WATER WORKS AND SEWERAGE

February, 1933 — Editor — Vol. LXXX. No. 2

The Wards Island Sewage Treatment Works of New York City, Nearing Completion. Photo by Fairchild Aerial Surveys

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Bleaching Clay in Water Purification
Recent Progress in Sewage Treatment
Activated Carbon in Industrial Water Treatment

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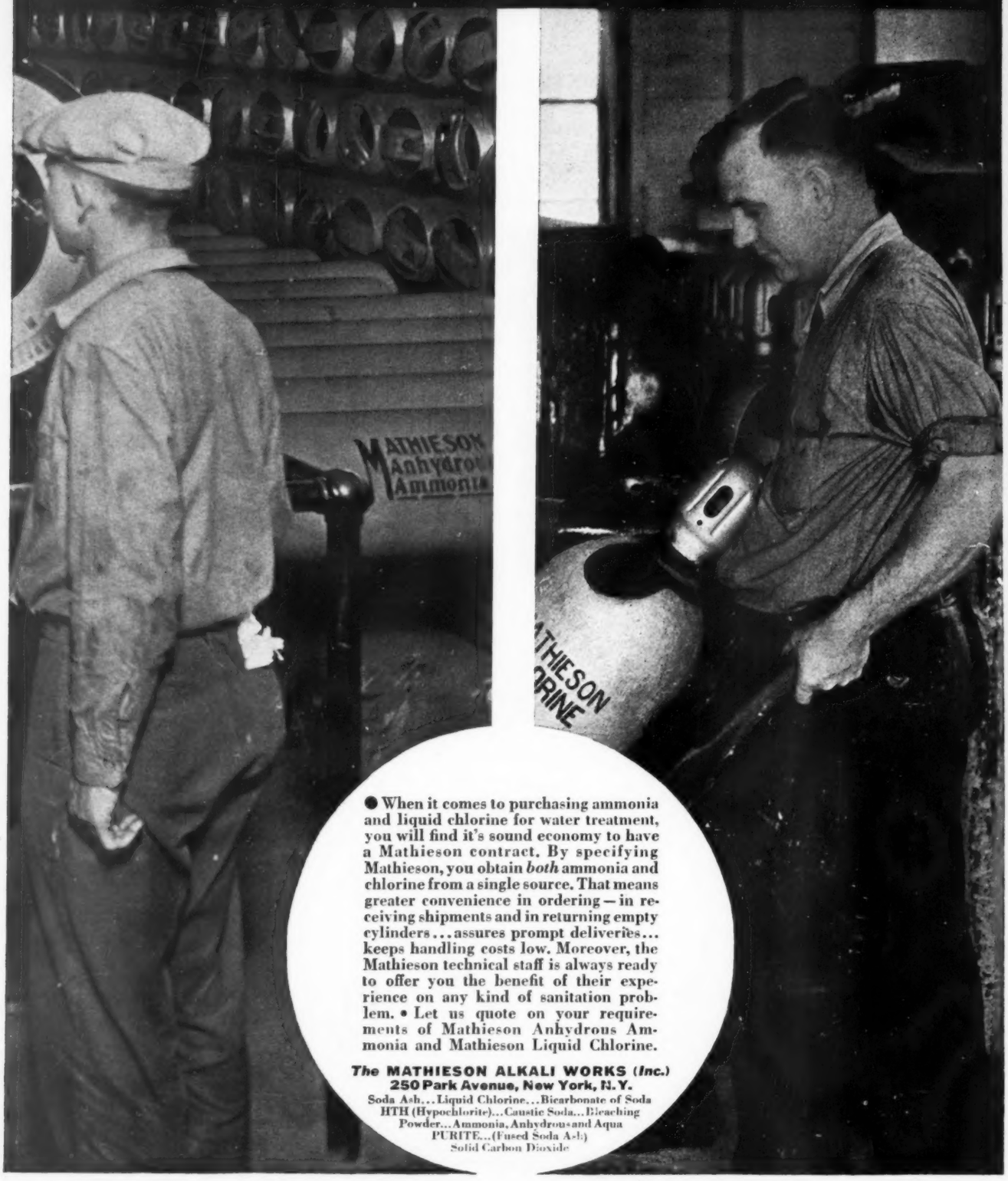

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WATER WORKS & SEWERAGE

L. H. ENSLOW, Editor

LEADING ARTICLES To Appear in the Next and Subsequent Issues:

J. Bryan Miller, Engineer-Manager, of Jacksonville, Texas, will relate an experience in "Overcoming the Cost of Obsolescence" in the local water works in which the new equipment was paid for out of operating costs saved during the first year following the replacement.

Robert B. Morse, Chief Engineer of the Washington Suburban Sanitary Districts, Hyattesville, Md., will relate developments wherein the use of light weight cast iron pipe in large diameter sewer construction and for lateral house connections in the Washington suburban district has led to economy, simplified construction and increased carrying capacities. Permanency of structure and other miscellaneous advantages are cited as reasons for selecting cast iron pipe for the Washington suburban projects.

Eugene T. Cranch, Superintendent of the New Rochelle (N. Y.) Water Company will continue with his series of articles of particular interest to Water Works Superintendents and Managers.

C. E. Keefer, Engineer in Charge of Sewage Disposal at Baltimore, Md., in reporting the outcome of "Large Scale Sludge Digestion Experiments at Baltimore," will discuss and summarize the hitherto unpublished information covering the relative merits of digester heating by direct addition of hot water to the sludge vs. the orthodox use of hot water coils fastened to the interior tank walls.

Dennistown Wood, Engineer of Tests of the Southern Pacific Railway System, in our March issue will describe water treatment practices on the Southern Pacific Railway lines—Zeolite softening being principally the process now used and to be extended.

E. Hurwitz, Chemist of the Chicago Sanitary District, and S. I. Zack, formerly Engineer with the Chicago Sanitary District and now associated with The Filtration Equipment Corporation, will set forth the results of "Tests on the Laughlin Process of Chemical Sewage Treatment" conducted by the authors.

E. T. Killam, Designing Engineer with Alexander Potter, Consulting Engineer, of New York City, presents an article dealing with the question of "Economic Significance of Pipe Linings" in which field tests under the author's supervision on large installations have proven the value of pipe lining from the dollars and cents point of view—a matter of some consequence in these times.

Carl Leipold, Superintendent of Filtration at Winnetka, Ill., will contribute a series of practical articles of interest to men in charge of water purification plants and distribution systems. Each article will be brief and readily comprehended.

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pH *And Its* Practical Application*

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William R. Kenny
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II—Hydrogen and Hydroxyl Ions
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WWS-2-33

*See this Book Review by an Authority—Sheppard T. Powell, Engineer—which appears in this issue on page 62.

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YES AND KERSLAKE REPORTS A SAVING OF 20 TO 50% OF CHEMICAL COSTS AT OSSINING BY PUTTING **NUCHAR** IN WITH ALUM JUST AHEAD OF THE MIXING TANK. HE RECOMMENDS USING **NUCHAR**, NOT JUST EXPERIMENTING WITH IT.

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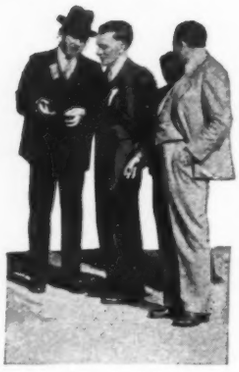

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I'm glad I came here and heard about it!

WATER WORKS AND SEWERAGE
Feb. 1933
No. 2
VOL. 80
A GILLETTE PUBLICATION

RECENT PROGRESS IN SEWAGE TREATMENT

By GEORGE W. FULLER*

George W. Fuller
Consulting Engineer

THE past year has been an unusual one in many ways. Financial conditions have resulted in the retardation of a number of major sewerage and sewage treatment projects and also have interfered with the setting up of new ones, both large and small. The business depression has developed a decided determination on the part of taxpayers to see a reduction in certain costs of government, especially local government, and this general feeling for retrenchment has operated against the issuance of bonds for needed municipal improvements. The establishment, last July, of authority for the Reconstruction Finance Corporation to aid so-called self-liquidating projects has given rise to expectation of being able to make headway in the construction of sewage disposal facilities through this means, though the practical effectiveness to date in sewage construction is slight.

Notwithstanding the abnormal business conditions, real progress has been made during the past year in the field of sewage treatment. Among the plants in operation or nearing completion may be mentioned Phoenix, Ariz., Birmingham, Ala., Wichita, Kan., Toledo, O., Hagerstown, Md., Dearborn, Mich., Morristown, N. J., Pottstown, Meadville and Coatesville, Pa., together with numerous smaller installations.

Of the plants in process of construction but not sufficiently advanced to go into service this year may be mentioned the Wards Island plant of New York City**; Providence, R. I.; Baltimore, Md. (additions to the Back River plant), the Elizabeth Valley Joint Meeting, and many smaller places.

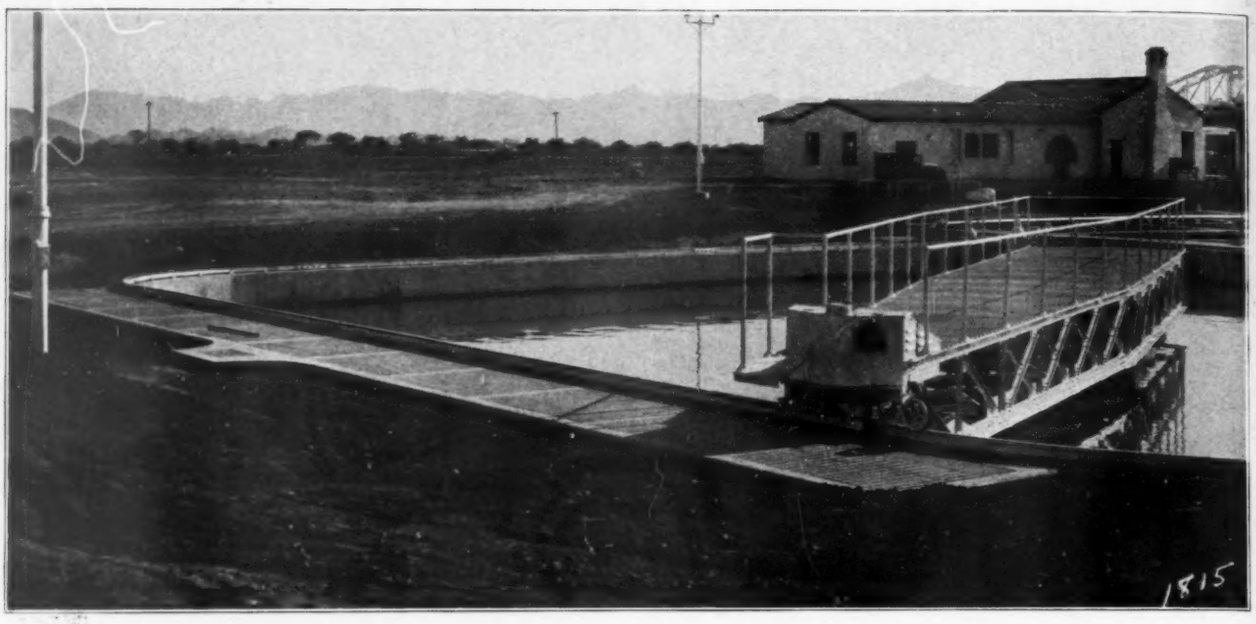
It may be remarked of the 14 projects mentioned above, six are activated sludge, seven are sedimentation with separate sludge digestion, and one is chemical precipitation. Space does not here permit a detailed comment regarding the interesting features of some of the newly constructed works. In general they exhibit more attractive and costly buildings and greater attention to the appearance of the grounds than at many of the older works. The processes themselves involve a greater tendency towards mechanization of the plant, the necessity for hand-labor being reduced to a minimum.

During the past year interest in sewage treatment in America has been concerned chiefly with the two items, first, chemical precipitation and, second, direct methods for handling and disposition of sludges.

Chemical Precipitation

Treatment of sewage by chemical precipitation is one of the oldest of the artificial methods of purifying sewage. The first patent is credited to one Deboissieu in 1762. During the middle of the nineteenth century when the government boards in England were undertaking to clean up the streams which had become intolerably polluted, innumerable processes for purifying sewage by chemical precipitation methods were tried out for a time,

*Of Fuller & McClintock, Consulting Engineers, New York.
**See front cover illustration.

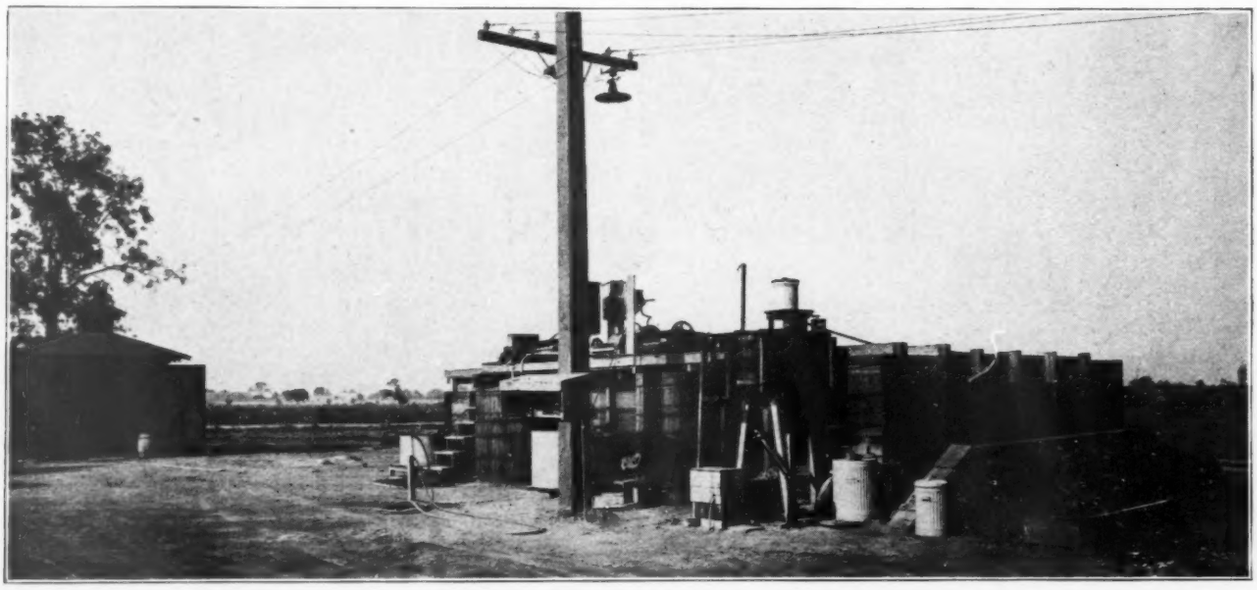


The Sewage Treatment Works of Phoenix, Ariz. Aeration Tanks to the Right, Are Shown in Another Picture

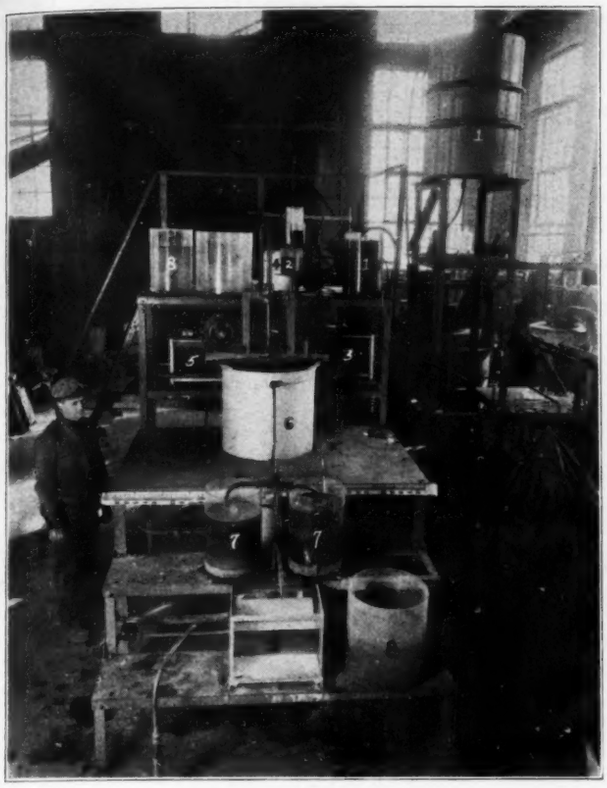
later to be abandoned in favor of biological processes. Birmingham was precipitating sewage with lime in 1872; Bradford adopted lime in 1874; Coventry used alum and lime in 1874; London treated the major portion of its sewage at the Barking and Crossness Works with lime and copperas, starting in 1889. The variety of substances used in connection with the patented precipitation processes during that era is surprising. For instance, the formula for the A.B.C. process, much discussed at that time, comprised the following ingredients: Alum, blood, clay, magnesia, manganate of potash, burnt clay, chloride of sodium, animal charcoal, vegetable charcoal, magnesia and limestone, the alum and clay being the two principal constituents. Of the above carefully compounded mixture, a dose amounting to 3,400 pounds per million gallons (U. S.) was recommended. In connection with other processes various salts of iron, both ferrous and ferric, were used as precipitants.

In America the use of chemical precipitation was carefully investigated by the Massachusetts Board of Health at its Sewage Experiment Station in Lawrence about 1889 when the effects of lime, alum and iron salts were studied. The late Allen Hazen, who conducted the Lawrence experiments, later put into practice precipitation methods for the sewage from the World's Fair Grounds in Chicago. Chemical precipitation methods were also employed for treating sewage at about 10 American cities, notably Worcester and Providence. With the exception of a few lime precipitation plants still nominally operated in New York City, the older precipitation plants have long been abandoned.

The older methods of chemical precipitation in England, originating primarily with the hope of producing valuable manure from human sewage, experienced no pronounced success. The early hopes for the economic recovery of valuable manure were not justified; the very voluminous sludge produced by precipitation was difficult to dispose of by methods then available; the effluent although frequently well clarified at the works was capable of later putrefaction and impairment of the receiv-



Experimental Chemical Sewage Treatment Plant at Palo Alto, Calif., Makes Use of Novel Process of Multiple Precipitation and Re-use of Precipitant—Ferric Chloride



The Guggenheim Laboratories Experimental Sewage Treatment Plant. Operated 24 Hours Daily for 8 Months, Handling a Flow of 2,500 Gal. Per Day

1—Crude sewage feed; 2. Ferric sulphate feed; 3. Ferric sulphate mixing and coagulation; 4. Lime feed; 5. Lime mixing and flocculation; 6. Clarifier; 7. Zeolite reactors; 8. Brine wash for regeneration of zeolite reactors; 9. Final effluent.

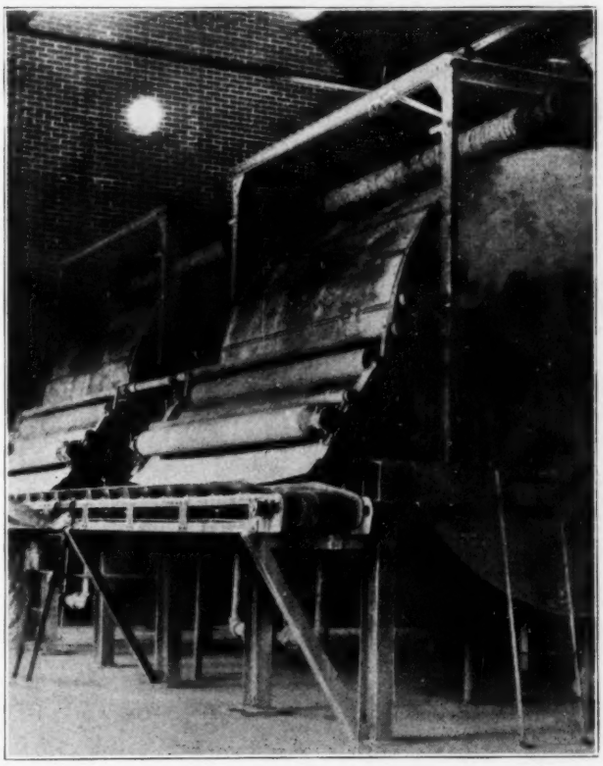
ing waters; and the cost of treatment was higher than by other methods that became available.

Ignoring the question of cost of chemical precipitation in comparison with that of other methods, it is interesting to quote the closing paragraph of Hazen's statements in the Special Report of the Massachusetts State Board of Health, 1890; Part II, p. 791, as follows:

"It is possible to remove from one-half to two-thirds of the organic matter of sewage by precipitation, with a proper amount of an iron or aluminum salt, and it seems probable that, in some cases at least, if the process is carried out with the same care as is required in the purification of sewage by intermittent filtration, a result may be obtained which will effectually prevent a public nuisance."

American experience on a working scale showed removals of total organic matter ranging ordinarily from 50 to 55 per cent. In this connection it is well to point out that more is known now, than 30 to 40 years ago, about the behavior of coagulating chemicals and the importance of efficient mixing and formation of floc and several special mixing and flocculating devices are now available. In addition, chlorine can be effectively used to bring about a substantial reduction of organic matter. Furthermore, rapid rate filters are better understood now than when chemical precipitation was previously practiced in this country.

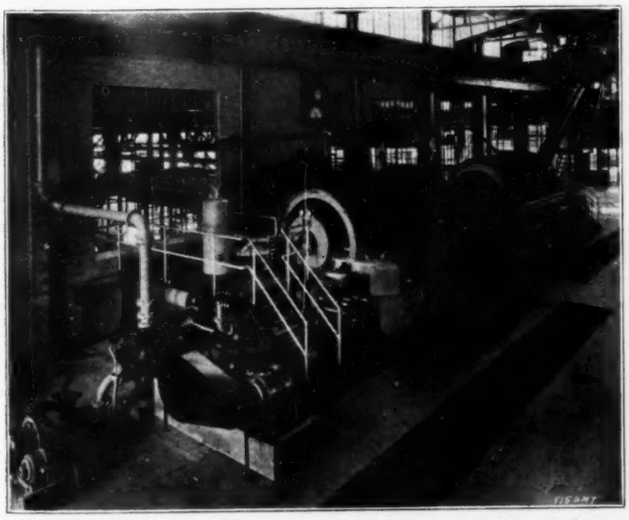
The revival of interest in chemical precipitation methods quite recently in this country was primarily due to the pilot plant of the Laughlin process installed at Coney Island, New York City, and operated for a number of months in 1932 on a sewage flow of 14,000 gpd. Interest has been greatly augmented by the construction and operation of the 8 mgd. plant at Dearborn, Mich., employing the Laughlin process, fully described in issues of WATER WORKS AND SEWAGE for October, 1931, and October, 1932. Essentials of the Laughlin process are



Wright Vacuum Sludge Filters at the York Township Plant in Ontario

effective precipitation of sewage solids by use of lime, paper pulp and a ferric salt, followed by sedimentation and the filtration of the clarified effluent through a special automatically cleaned filter, and the dewatering of sludge on rotary vacuum filters.

Recently considerable attention has been directed to the experiments of Stevenson at Palo Alto, Calif., where precipitation by ferric chloride and chlorine in two or three stages has been carried out at a plant handling 36,000 gpd. The special features of the Palo Alto experimental installation described in the Nov. 10, 1932, issue of Western Construction News, are the efficient chemical mixing arrangements, the "regeneration" of precipitated sludge from the final tank, with chlorine,



Oliver Vacuum Sludge Filters at the Dearborn Disposal Plant, Using the Laughlin Chemical Treatment Process

Aeration Tanks at Phoenix, Ariz., Sewage Treatment Plant, Showing the Aeration Mechanism with Air Diffusion Plates Along Center Bottom

and the return of this sludge to the incoming sewage, whereby economies of chemicals are claimed.

Another interesting development of which little has been heard is the re-circulation of sewage sludge precipitated with alum, as carried out by Cabrera at a 60,000 gpd. installation at Wilmington, Del.

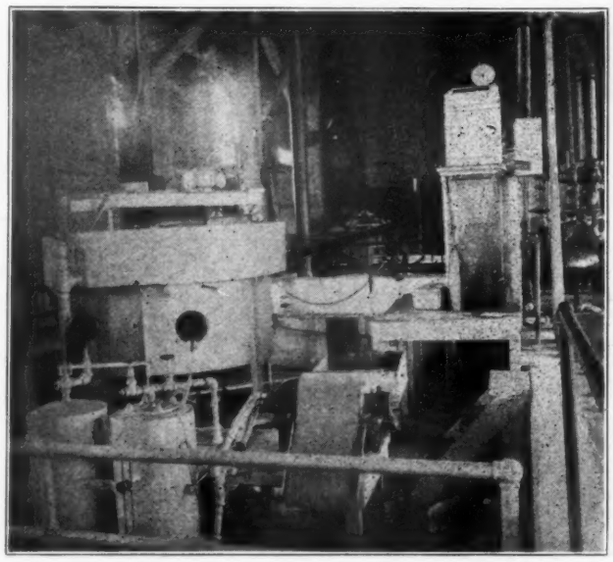
Chemical precipitation methods are reported in use at two towns in Ohio by the Travis process which is said to employ marl, lime and ferrous sulfate. At Atlanta, Ga., there is being installed at the Peachtree works, an experimental chemical precipitation plant of 1 mgd. capacity, using the Lewis process, which will employ Cottrell precipitator dust from cement mills, lime, ferrous sulfate and ferric chloride.

One of the most interesting developments in the way of chemical precipitation is that represented by the Guggenheim process as described by Mr. Cappelin-Smith in the December 1932 issue of WATER WORKS AND SEWAGE and also by Messrs. Gleason and Loonan in a paper before the New York State Sewage Works Association on January 17, 1933.* This process uses ferris sulfate and lime for coagulation of the sewage solids, which are then settled in the usual manner. The clarified effluent is then passed through zeolite filters for abstraction of free ammonia and other nitrogen compounds which are not removed by precipitation or by filtration through sand. The brine used in regenerating the zeolite filters is processed further for recovery of its ammonia content. Other special features of the Guggenheim process are the dewatering of sludge on rotary vacuum filters and the drying of the filter cake in a rotary drier, followed by incineration. The ash, containing the iron used in precipitating the sewage, is redissolved in sulfuric acid and reused as a coagulant. The experimental installation of 2,500 gpd. exhibited at the Guggenheim laboratories in New York City has now been translated into a 25,000 gpd. pilot installation for study by the Sanitary District of Chicago, expected to be in operation in February.

It is not proposed to discuss here the merits or demerits of the several newer types of chemical precipitation. Whether these processes will find permanent status in the sewage treatment field depends largely on practical experiences at full scale plants under varied local conditions. Certainly there is indicated in these developments, along chemical and mechanical lines, tendency to provide quicker and perhaps more readily controllable methods for sewage treatment than are inherent in the biological processes.

Intermediate Degrees of Treatment

Plain sedimentation will remove from 33 to 40 per cent of B.O.D. depending upon local conditions. The lower



Experimental Plant at Coney Island, N. Y.—Laughlin Process Employed

*A digest of the Gleason–Looman papers is printed elsewhere in this issue under heading of this meeting of the New York State Sewage Works Association.—Editor.

figure applies to dilute, stale and comminuated sewage as at Chicago, and the higher figure to fresh and fairly concentrated sewage. For so-called complete treatment, embodying either the activated sludge process or trickling filters, the B.O.D. removals may be taken to range from about 85 to 92 per cent depending upon local conditions.

The chemical precipitation processes as now being studied suggest at once an intermediate degree of treatment of, say, from 60 to 80 per cent of B.O.D. removal, according to local conditions, such as freshness of sewage, effectiveness of filtration, chlorination or other steps following the settling tanks, etc. These processes may serve some local requirements where plain sedimentation or chemical precipitation as practiced in years now past would be inadequate, at least for certain portions of the year; and they may be considerably less costly than the so-called complete treatment methods.

The practicability of such intermediate processes of treatment can only be learned by tests on a suitable basis to show extent and reliability as to purification and also costs for construction, operation and maintenance, in comparison with proven processes now in practical use.

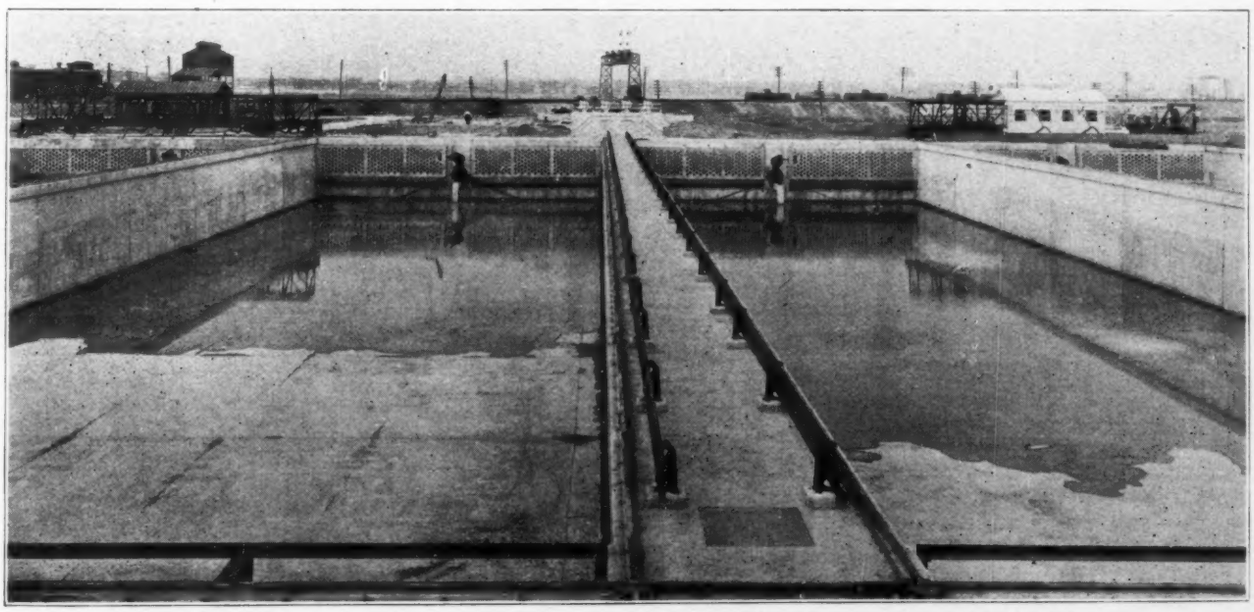
Sludge Disposal Methods

Secondary only to the interest in chemical precipitation during the past year has been the interest in new methods or improved methods for handling and disposing of sewage sludges. The use of acid conditioning agents, such as sulfuric acid, alum, chlorinated copperas and ferric salts for coagulating activated sludge and making it amenable to dewatering on vacuum filters is now quite familiar through the operations at Milwaukee, Chicago, Houston, Pasadena, Charlotte and High Point, N. C., over a term of years. Practice has settled down to the general use of ferric chloride as the best of the conditioning agents. Pasadena has now substituted ferric chloride for alum previously used with diatomaceous earth as a filter aid, but Charlotte has lately used ferric sulfate as a substitute for ferric chloride. Dearborn is now precipitating with ferric sulfate, but uses ferric chloride as a filter aid.

Considerable attention has been given during the past year to conditioning of activated sludge for filtration by the use of paper pulp alone or in combination with lime. The York Township (Ontario) works have been employing paper pulp as a filter aid, with and without lime, and the works at Hagerstown, Md., soon to go into service, will use paper pulp and lime for conditioning a mixture of activated sludge, fresh solids and fine screenings, prior to dewatering on vacuum filters. The indications are that the alkaline filter aids do not give as great a yield of sewage solids per unit area of filter as do the acid agents, but the alkaline sludge cakes are not nearly so apt to cause nuisance where it is necessary to dispose of the cake on land, instead of incinerating or converting to dry fertilizer. Since the incineration program must be deferred temporarily, this was the chief factor in the selection of the paper pulp and lime process for Hagerstown. In connection with Hagerstown it may be interesting to record that the fine screenings and excess activated sludge have been conditioned with lime for a period of some seven or eight years and the sludge dewatered on open sand beds, with only partial success however.

One of the significant developments is the program now being tried out at Chicago on a fairly sizable scale for dewatering mixtures of fresh solids and excess activated sludge on vacuum filters, using ferric chloride as a filter aid. This project calls for drying of the filter cake followed by incineration. If the trial results are satisfactory the digestion of sludges at Chicago and many

Junction Chamber, Meter Building and Chlorinating Station on the Elizabeth Valley Joint Trunk Sewer, Union Township, N. J. Vacuum Type Chlorinators and One Ton Containers Used)



Joint Meeting Sewage Treatment Works at Elizabeth, N. J. The Two Sludge Removal Machines, Serving Four Tanks, Are Shown at the Far Ends of the Outside Tanks

other large installations will be eliminated. The method is too highly mechanical in its present stage of development, to make it attractive for small works, notwithstanding its apparent economy for large plants.

Another development in sludge handling methods of outstanding interest is the use of vacuum filters for dewatering digested sludges, thus retaining the digestion stage, but supplanting the customary sand sludge beds.* Notable experiments along this line have been carried out during 1932 at Baltimore and Columbus. At Chicago modified Berrigan filter presses are also being tested.

About a year ago, in connection with technical meetings in New York, opportunities were afforded to inspect in operation at Yonkers a spray drying equipment for sewage sludges. Equipment of this type has been recommended for Plainfield, N. J., in lieu of extensions needed in sludge drying beds, and doubtless will be installed shortly.

Centrifuge methods for partially dewatering sewage sludges have been considered for a long time, but have not found a foothold mainly on account of the necessity of operating by batch methods. Lately, prominent manufacturers of high-speed centrifuges have constructed types suitable for continuous operation and they hope to develop, by field trials now in progress, machines suitable for partial dewatering of activated sludge and other sewage sludges.

In summary, recent progress in sludge handling has been along mechanical and chemical, as distinguished from biological lines. Digestion of sludge still has its place however.

Current Trends in Treatment Processes

Of the familiar processes used in sewage treatment only brief comments need be made. There has been improvement in details of a number of the mechanical devices on the market and there is keen competition in competitive mechanisms for most of the processes.

The popularity of mechanical grit removal is increasing rapidly and more attention is being given to methods of removal of grease and scum as a distinct rather than an incidental operation.

In the direction of screening the trend is decidedly toward mechanically-cleaned bar screens of three-quarter to one-inch spacing. Notwithstanding, there was recently installed at Norwalk, Conn., fine disc type screens ahead of settling tanks.

The past year is noteworthy for the appearance in some of the new plants of settling tanks with traveling-crane type of cleaning mechanism of the type previously used in Germany.

Many of the small sprinkling filter installations are now employing the revolving type of distributor for circular beds and the traveling-crane type for rectangular beds instead of the usual sprinkler nozzle.

Use of filters to finish off the effluent shows distinctive trends. Following the lead of the Grand Canyon plant, rapid sand filters are used at Barrington, N. J., for the effluent of the activated sludge process. Rapid sand filters are used also in two or three small sprinkling filter installations in Pennsylvania to finish off the effluent from the final tanks. The Dearborn plant has upward-flow magnetite filters to filter the effluent from clarifiers, following chemical precipitation. The Guggenheim process employs zeolite filters following chemical precipitation. At the Rockville Centre, N. Y., activated sludge plant rotary vacuum filters are being installed for filtering with the aid of paper pulp, the entire clarifier overflow for the purpose of eliminating suspended solids, which were bothersome in plugging the sand beds.

Recent developments in the activated sludge process have been aimed at reduction of air and power requirements. The intermittent application of air by an undulating valve at Chicago has reduced the air consumption to the lowest of any of the large plants employing the diffuser method of aeration. There has also been an increase in the number of installations employing mechanical aeration or a combination of mechanical and diffuser aeration such as adopted at Phoenix, Ariz., Muskegon Heights, Mich., and Newark, N. Y.

There is little to record in sludge digestion except a tendency to use temperatures 10 to 15 degrees higher than the 80 degrees first considered to be the optimum. Digestion of fresh solids may be considered as being on a stable and well-established basis, but digestion of activated sludge with its high water content has a good many handicaps. The use of the heated separate digester, however, is easily the outstanding method of taking care of sludge for the majority of recent installations and particularly the small ones. Utilization of digester gases is generally practiced for heating the digesters and buildings, and in some cases for auxiliary power.

Chlorination continues to make progress as a valuable adjunct in sewerage disposal practice. Chlorination of sewers to prevent or retard septic action, thus lessening odors and sewer deterioration by sulphurous gases, and for the reduction of loadings on treatment processes, is increasing in application. Notable examples of large scale chlorination for such purposes during the past year are found at Elizabeth, N. J., and Cleveland, O., for lessening odor, and in Los Angeles County, Calif., for lessening odors and increasing the capacity and efficiency of the county's activated sludge plant.

For oxygen demand reduction and improvement in stream conditions, including the control of biological growths, chlorination of the effluents at Chapel Hill, and Winston Salem, N. C., and at Baltimore, Md., has been reported to have proven helpful procedures.

*In an issue of Water Works and Sewerage in the near future there will appear an article comparing costs of sludge dewatering on sand beds as against vacuum filters. The data is enlightening.—Editor.

Serving Political Machines

In a recent address Samuel Seabury who will be remembered as the investigating attorney who turned up much questionable if not actually corrupt practices during the investigation of New York City's political machine in 1932, said the following in an address to a group of young men:

"Do not be deluded with the idea that one can be subservient to the political machine until one obtains power, and then develop independence. Independence, like character, of which it is a part, is a growth. One cannot cultivate the capacity for independence by subserviency. There is today a splendid opportunity for young men if they can only be given proper leadership. They have the right to look to older men for leadership and counsel and those who sustain such a relation toward them have resting upon them the obligation to guide but not to kill or divert, the fine energies, enthusiasms and ideals which they bring to their work."

May Mr. Seabury's remarks be remembered long by young men seeking or holding municipal, state and national positions.

FILTRATION PLANTS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. BAYLIS, Associate Editor

Physical Chemist, Bureau of Engineering, Chicago, Ill.

MECHANICAL FLOCCULATORS

IN the January issue of WATER WORKS AND SEWERAGE the writer mentioned mechanical flocculators as a step forward in conditioning water before it reaches the filter beds so as to reduce the load on the filters. It is well known that the better the water is prepared for filtration the easier it becomes to produce a good quality of filtered water. The probability of considerable development along the line of producing better coagulated water, which in turn produces better sedimentation, justifies a more extended discussion of mechanical flocculators. A description of the flocculators which were installed in the Richmond, Va., filtration plan was given by Smith[1] in the April, 1932 issue of WATER WORKS AND SEWERAGE. This article is written largely to augment the facts brought out in Smith's article.

Good Mixing Is Essential for Efficient Results.—Those who have followed the writer's discussions on coagulation and sedimentation within the past few years are aware of the efforts which have been made to impress upon designing engineers the importance of providing efficient mixing and coagulation so as to secure effective sedimentation. Years ago it was the opinion of many that a certain amount of coagulated matter should go to the filters to make them function properly. Now it is known that it is better to hold the coagulated matter reaching the filters as low as is practical, and that better filter performance is obtained when the amount of coagulated matter going to the filters is very low than when it is high. Naturally no definite amount of coagulated matter can be set as the economical amount, for that will depend upon the cost of reducing the coagulated matter by coagulation and sedimentation. In one plant the economical amount may be a flocculation which produces turbidity of 2, whereas in another plant it may be turbidity of 10 or more. The amount may vary considerably with the changing character of the water in a single plant. The writer has observed conditions in plants with good mixing and good sedimentation in which it was impossible to reduce the coagulated matter which was going to the filters to less than a turbidity of 15 to 20 at certain times, whereas under ordinary conditions there was no difficulty in reducing it to about 5 in these plants. Such conditions make it impossible to set any exact figure to which the coagulated matter should be reduced.

Sufficient Coagulant Should Be Added to Entrap Practically All Particles of Mud, Bacteria, etc.—The first requirement in coagulating water is to add enough of the coagulant so that all of the fine particles of suspended matter, bacteria and microörganisms will become entrapped during flocculation. There is a definite minimum amount which should be used regardless of how good

Fig. 1. Mechanical Flocculators in Settling Basin at Richmond, Va.

the mixing and settling may be in the plant. This minimum amount will vary with the amount and character of the suspended matter, the kind of coagulant and the temperature of the water. Perhaps other factors also may have some influence. The amount will vary from about 3 p.p.m. of aluminum sulfate for low turbidities to 50 or more p.p.m. for highly turbid water. Other efficient coagulants have to be used in about the same ratio. The amount of coagulant used influences the rate of floc formation, and a good flocculation will likely be produced in shorter time with highly turbid water than is required for an equal amount of coagulant when the turbidity is low.

Mixing Time Is Largely a Guess.—Prevailing practice in the design of filtration plants heretofore has been for the designing engineer to assume that the water should have a certain definite period of mixing. This assumption is usually only a guess based upon observations at other plants, and frequently it is about an average of what is being used in plants handling water of similar character. After the plant has been constructed and put into operation, the one operating it adds sufficient coagulant to produce a good quality of water, and so long as the quality of the filtered water is good it is assumed that the plant is operating efficiently. The operator, as a rule, has no idea whether the layout is efficient or is wasteful of chemicals. He calls the plant efficient because it turns out a fairly good quality of water. This, of course, is the most important consideration, though some weight should be given to the cost. There are a few plants where it is not possible always to turn out an excellent quality of water, and improvement in the coagulation of the water is highly desirable. It is believed that an increase in the mixing time will improve the coagulation in a number of existing filtration plants to the extent that the improvement will lessen the cost of the treatment many times that of the cost of providing for the additional mixing time.

Slight Excess of Coagulant Should Be Used, but This Does Not Lessen the Importance of Having Efficient Mixing.—The writer is not an advocate of operating so close to the minimum amount of coagulant necessary to produce good water that irregularities in the application of the chemicals to the water occasionally will cause the water not to be properly coagulated. A good quality of water must be produced all the time regardless of cost, yet it is poor economy to construct an inefficient plant just because it is known that the operator may, by the use of larger amounts of chemicals, produce good water. If it requires, with good mixing and settling, an excess of 20 per cent of coagulant over the minimum amount necessary to produce perfectly clear water in order to overcome irregularities in the plant operation so that the water will be coagulated properly all the time, a plant not properly designed would still have to use approximately the 20 per cent excess over the minimum requirements of the plant as designed.

This is not to convey the impression that 20 per cent of coagulant over the minimum is necessary in all filtration plants to insure properly treated water, for some plants are so designed and operated that an excess of only 10 per cent may be used safely. Such factors do not lessen the importance of designing a plant to produce the desired quality of water at the cheapest cost. If a plant is designed with insufficient or improper mixing and as a result 25 per cent more coagulant is required than would be required for a plant having a properly designed mixing basin, this 25 per cent excess of coagulant is just that much money wasted. This is not saying that all plants are wasting 25 per cent of the coagulant due to improper mixing, but the number probably is much larger than is realized. It is true that the coagulant used for treating the water does not represent a large percentage of the total cost of treating and pumping the water, nevertheless waste should be avoided, especially during times like the present when there is real demand for economy wherever possible.

Expensive Additions to Mixing Basins Are Less Likely to Be Undertaken.—The operators of a number of water treatment plants realize that their mixing facilities are not adequate, yet they hesitate to ask for an extension of the plant to correct the deficiency in mixing, the reason being the high cost of the extension. Many operators of municipal plants are in the position that no questions are asked in regard to the cost of chemicals used to treat the water, but much explaining would be necessary to persuade the city council to provide funds for changes in the treatment plant. The lower the cost of the change the more likely it is that the city will provide funds. To meet the demand for more efficient mixing at a very low cost, mechanical flocculators for installation in existing settling basins have been developed. In many plants the cost of installing these flocculators should be only a very small percentage of the cost of enlarging the usual type of mixing basin.

Attempts to Produce Better Coagulated Water.—The writer, for a number of years, has given thought to how additional mixing might be provided for filtration plants without expensive construction work, yet nothing so simple as the flocculator developed by Smith[1] was conceived. As far back as 1916 he inserted baffles in the entrance end of one of the settling basins at Jackson, Miss., to give longer mixing so as to produce better flocculation.[2] The engineer who designed the plant stated that a mixing basin was not necessary. The mixing time provided before the treated water reached the settling basin was only about one minute. Soon after starting the plant in operation it was evident that more mixing was needed, yet it was difficult to persuade the city council to allow an appropriation of less than $100 to construct a short mixing basin. Considerably over ten times the cost of the mixing basin was saved in chemicals the first year, besides producing a better filter effluent. This is an extreme example and such savings must not be expected at other plants.

In the construction of the mixing basin at Jackson, which was the over and under baffle type, the outlet of the basin extended entirely across the entrance end of the settling basin and was such that the water entering the settling basin produced an overturning or rotary motion somewhat like what would be produced by one line of a transverse flow flocculator. It was noted that some of the heavy particles of flocculated matter which had settled to near the bottom were drawn back into the incoming water. It was thought that this helped in producing a more rapidly settling flocculation, though there was no way of telling just how much good could be attributed to this phenomenon. It was evident that most of the improvement in the coagulation was due to the increase in mixing time.

An apron was fastened to the top of the entrance baffle of one of the settling basins in Baltimore about 1919 so as to produce an overturning of the water as it flowed into the settling basin. This also brought some of the heavy sediment back and mixed it with the incoming water. This seemed to improve the efficiency of the basin slightly, but it did not meet the writer's expectation. The opinion was then formed that probably the best means of improving the coagulation was to provide fairly long mixing periods with the usual types of mixing basins.

The flocculator conceived by Smith gives additional

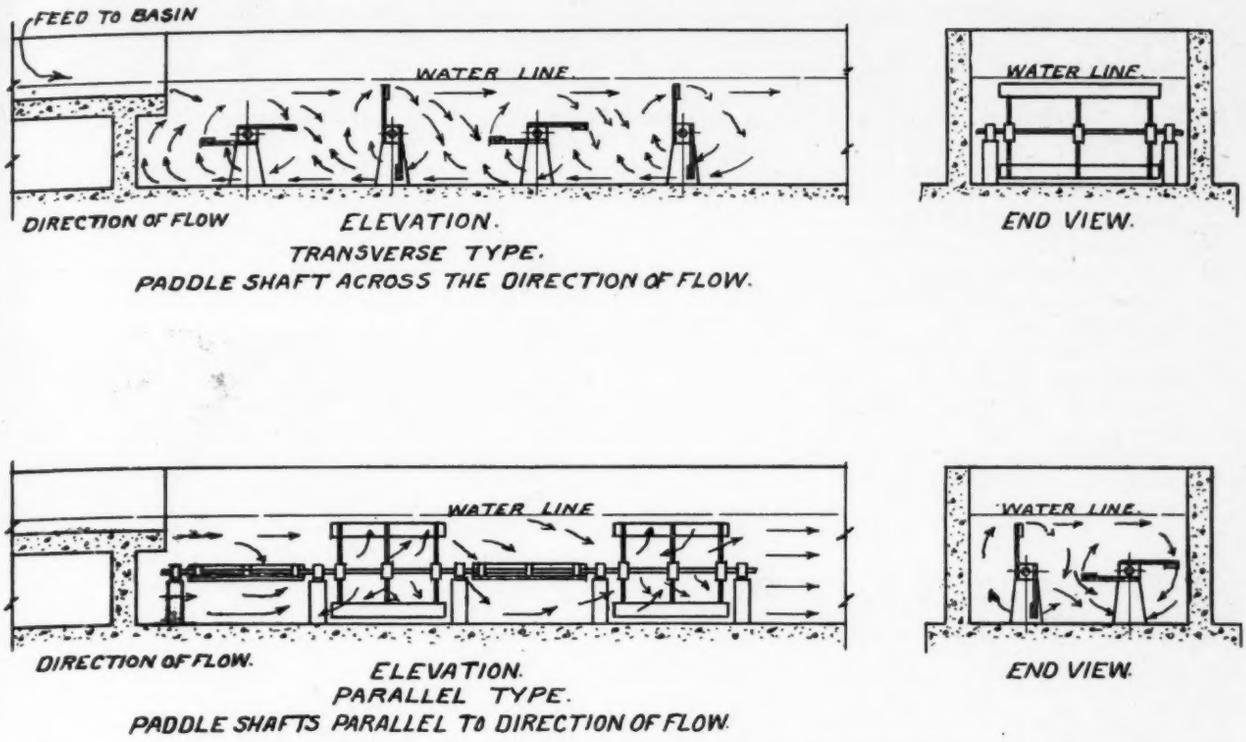


Fig. 2. Diagrams Showing Distribution and Direction of Flow in Transverse and Parallel Flow Types. Dorr Co. Flocculators.

mixing, and that is its main purpose. Pulling part of the sediment back so as to mix it with the incoming water appears to be an advantage, though not of equal importance to providing additional mixing. The flocculator not only provides additional mixing but there are no gates and conduits for the coagulated water to pass through and break up much of the flocculated matter as is the case in many filtration plants. Where a plant already has good mixing it may still be possible for the flocculators to improve conditions.

Description of the Flocculator.—The writer is indebted to the Dorr Company for illustrations and description of the flocculators they manufacture. The flocculators will not be described in detail though it is hoped that enough information will be given to enable one to form some idea of the construction. The transverse flow type illustrated in Figs. 1 and 2 is modeled after the Richmond flocculator. Figure 1 is photograph of the flocculators in one of the settling basins at this plant.

The shafts are made of extra heavy steel pipe, and should be supported on concrete piers, though any type of support which will hold the shaft rigidly may be used. Special bearings suitable for submerged service should be provided. The paddle arms are made of angle iron, and the paddle blades are 2-in. wooden boards. The width of the paddles vary according to conditions, which will be explained later. Usually they are wider at the inlet end of the basin and are reduced in width for each succeeding row of the transverse type, or each succeeding section of the parallel type. Diagonal 2-in. by 4-in. members are fastened to the paddle arms and serve to prevent a dead zone in the flow of water as well as a brace for the paddle arms.

The paddle sections are usually a maximum of 12 ft. long, but vary to shorter lengths, especially where 12-ft. sections do not fit the width of the settling basin. Each adjacent section is set at a 90 degree angle from the adjoining ones where only two paddles per section are used. The shafts are driven by roller chain and sprockets from a speed reducer.

In the transverse flow type the paddles rotate about a horizontal axis perpendicular to the direction of flow. The paddles of the parallel flow type rotate on an axis in line with the direction of flow. The paddle diameters for various depths of water are shown in Table I.

TABLE I.—PADDLE DIAMETER FOR VARIOUS DEPTHS OF WATER

Low Water Depth (Feet)	Paddle Diameter (Feet)
6	5.5
8	7.5
10	9.5
12	11.5
14	13.5
16	15.5
18	17.5
20	19.5

The paddle diameter should be 0.5 to 0.75 ft. less than the low water depth, but there should be no objection if the paddles occasionally project above water surface. The clearance between the paddles and the floor should be 0.25 to 0.5 ft.

A variable speed drive allows peripheral speed variations of from 1.8 to 0.6 ft. per second. The power required will vary with the speed employed.

For securing a gradually decreasing rotary water velocity in the transverse flow type, the width of the parallel blades should be reduced for succeeding paddle rows depending on the number of rows used, but in no case should the cross arms be less than 4 in. wide for the last row. For example, in a 12-ft. water depth tank with 5 paddle rows, 12-in., 10-in., 8-in., 6-in., and 4-in. paddles on each succeeding paddle row may be used. The same applies to the paddle sections in the parallel flow type; that is, the widths of the paddles are lesser in each succeeding section.

Advantages of Flocculators.—The advantages claimed for flocculators are:

1. An appreciable saving in chemicals.
2. Improved quality and purity of water because of

thorough and effective coagulation and removal of impurities.
3. Reduction in cost of plant operation, such as less frequent washing of filters.
4. Increased clarifier, filter, and, consequently, plant capacity.
5. Low power and operating cost.
6. Positive improvement in general plant operation.
7. Consistent results possible in spite of fluctuations in character of incoming water.
8. Low loss of head.
9. Tapered paddle agitating effect.
10. Low installation cost compared with other mechanical mixers.
11. Smooths out influent distribution.
12. Easy to fit into existing plants.
13. Improves the efficacy of activated carbon treatment by sustained and increasing contacts of carbon particles with impurities.

The writer is of the opinion that these claims are conservative.

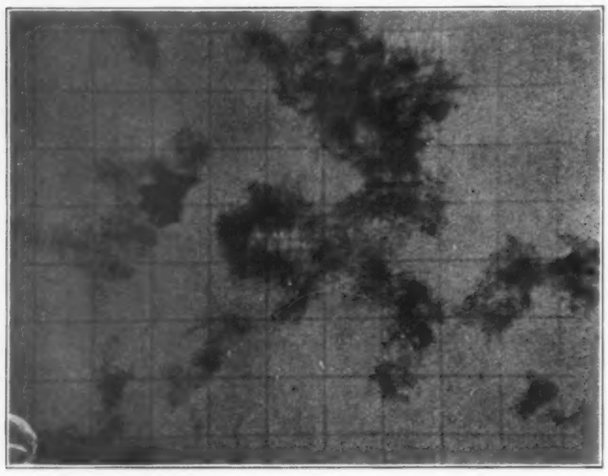


Fig. 3. Microphotograph of Particles of Poorly Formed Coagulation.

Transverse Flow Type Believed Most Efficient.—There is no specific information as to which type of flocculator is most efficient in producing rapidly settling flocculation, but it is believed that the transverse type will give slightly better results in most plants. Either type should result in considerable improvement in the flocculation of the water in treatment plants where there is insufficient mixing time or where the flocculation is partially broken up in passing to the settling basins. It is believed there is an advantage in bringing the heavier coagulated particles back and mixing them with the incoming water. The parallel type continues the gentle agitation to build up compact and well formed flocculated particles, but does not bring the heavier particles back and mix them with the incoming water as is the case with the transverse type. Neither is short circuiting so positively prevented by the parallel as by the transverse type.

What the Flocculator Does to Produce Good Coagulation.—It seems that many are under the impression that so long as the flocculated particles are fairly large they will settle rapidly. Large particles do aid materially in hastening the settling, though the size of the particle is not the only factor affecting the rate of settling. Both the size and the specific gravity of the particles have considerable influence. Where the water is highly turbid the entrapped particles of mud, silt, etc., give considerable weight to the flocculated particles and may cause them to settle fairly rapidly even though they are not compacted to maximum density. With fairly low turbidity water, however, it is important to produce compact particles of flocculated matter so as to hasten sedimentation. This can be done only by prolonged gentle agitation.

The microphotograph in Fig. 3 shows flocculated particles formed when the agitation was too gentle to form compact particles. Such particles do not settle rapidly and are easily broken up in passing through gates, valves and conduits leading from the mixing basin to the settling basin. The particles shown in Fig. 4 are more

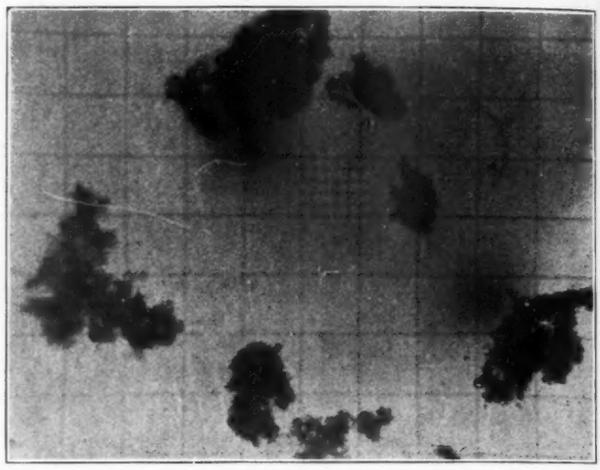


Fig. 4. Microphotograph of Particles of Well Formed Coagulation. The Large Squares Are 0.1 mm.

perfectly formed, and are the result of prolonged mixing at the proper violence of agitation. Some of the particles formed were much larger than those shown in the photograph, but were of the same compact formation. Such particles do not break up so easily, and settle more rapidly than the particles shown in Fig. 3. The writer has not observed flocculated particles produced with flocculators, but it seems probable that such a device tends to produce compact particles such as pictured in Fig. 4 rather than the loose variety.

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House Bill 649

A bill of importance is being proposed for passage by the Massachusetts legislature. House Bill No. 649 is entitled "An Act Relative to Municipal Water and Sewage Disposal Works."

If this bill becomes law, it will put the accounting of municipal water works on substantially the same basis as that now in force regarding municipal lighting plants, with the added requirement of credit to the works for all water and fire protection service furnished to the municipality, and charge against the works an amount equivalent to taxes; it would also require definite appropriations from the water works revenue for the support of the works, including a depreciation fund, and provide that not less than 25 per cent of the net earnings should go into a reserve fund, the depreciation and reserve funds being usable only for extension or replacements. The net earnings of the works would also be limited to a reasonable return upon the investment and the proportion of the earnings which might be appropriated to other municipal uses would be limited.

MEETING OF NEW YORK STATE SEWAGE WORKS ASSOCIATION

THE Fifth Annual meeting of the New York State Sewage Works Association was held in New York City at the Hotel McAlpin on January 17, 1933. The attendance of 185 represents the largest recorded in the history of the Association, the membership of which has now reached 262. The papers presented were unusually interesting.

A. F. Dappert, Incoming President, N. Y. S. S. W. A.

The timely paper by Abel Wolman on the subject of "Facts and Fancy in Sewerage Financing" constitutes a real contribution to the literature on financing the construction of and paying for operation of sewerage systems and treatment plants. The discussion led by George W. Fuller, and that by H. C. Delsell, Engineer of the Portland Cement Association, who have had contact with the R. F. C. and Legislative Committees drawing up sewer rental laws was particularly enlightening as to the existing situation in sewerage financing throughout the country and what appeared to be the most effective means of speeding up the much needed sewerage construction. The discussion was pointed, brisk and meaty.

The talk and demonstrations given by G. W. Jones of the U. S. Bureau of Mines on the subject of "Explosion and Health Hazards in Sewage Works Operation" brought out some extremely interesting and important phases of the "safety-first" side of sewage disposal. Mr. Jones remarks and recommendations concerning the design, location, etc., of flame-traps on sludge digestion tank gas-lines were of a particularly practical nature.

George W. Fuller, Luncheon Speaker

George W. Fuller, Consulting Engineer of New York City, in a luncheon address, covered the past and probable future developments in respect to the financing of sewerage projects through aid from the Reconstruction Finance Corporation. He cited the important recent decision of the Ohio Supreme Court which stated that municipalities and corporations must comply with orders of the State Health Department in the matter of providing sewage treatment and this regardless of objections by municipal officials on grounds of lack of funds for current expenses or the adverse vote of taxpayers on bond issues for the purpose. It was Mr. Fuller's opinion, the Ohio case would have a far reaching effect and will have a great deal to do with future developments in the field of sewage disposal.

Mr. Fuller stressed another important element in securing more prompt action of municipalities in sewage disposal—the weight of public opinion as expressed through the press. He cited the pressure brought on city officials by important taxpayers and residents of New York City through the local papers and in other ways. The recent developments in cleaning up had been the result—the Wards Island Plant being hurried through as it otherwise would not have been. Bathing beach protection had been another important reason for speeding up developments.

Taxpayers generally, he thought, had not sufficiently realized the necessity of providing sewage treatment sooner or later and had not appreciated the fact that much money could be saved in the end by proceeding with construction of plants at this time of labor distress and abnormally low material costs. He believed that a lot could be accomplished by giving more publicity to this important phase of the question—appraisal of the public.

Present Trends in Sewage Treatment

Mr. Fuller, in commenting on the recent trends in sewage treatment, said that he had recently visited 15 important treatment plants on a trip from coast to coast. He found the appearances of plants much improved and the use of mechanical equipment extensive. An important development had been the reduced cost of aeration

Fifth Annual Meeting of the New York State Sewage Works Association, Hotel McAlpin, New York City, Jan. 17, 1933.

by combination of compressed air and mechanical agitation.

Chemical precipitation of sewage appeared to be coming back into the picture. Whereas the chemical processes of the nineties had been able to remove but 50 per cent of the organic content of sewages a combination of improved chemical precipitation, with chlorination, could be counted on to remove 60 to 75 per cent of the putrescible matter from sewages. There existed a real demand for an intermediate degree of treatment and modernized chemical treatment had substantial possibilities. Mr. Fuller cited some of the work under way in the development of chemical processes—that at Palo Alto, Calif., Dearborn, Mich., Wilmington, Del., New York and Chicago in particular.

Mr. Fuller commented on the substantial recent developments in sludge handling and disposal wherein the mechanical vacuum filter had proven its great value in dewatering sludges conditioned with lime, and paper pulp or ferric iron coagulants.

Henry W. Taylor, Recipient of the Kenneth Allen Award

The Kenneth Allen* Memorial Award was voted to Henry W. Taylor, Consulting Engineer of New York City for the outstanding paper presented before the Association during the year 1932. President Earle B. Phelps in presenting the award complimented the recipient on his method of studying operations of sewage treatment works and application of findings in subsequent design. The paper in question, "Special Features of Design Construction and Operation of the Lake Saranac Sewage Treatment Works," was presented by Mr. Taylor at the Lake Saranac meeting. Mr. Taylor, in accepting, said that in his opinion "A plant, once completed, became a living issue and not one to be forgotten; one that could be taught to talk for the benefit of engineers—or otherwise."

Henry W. Taylor Recipient of Kenneth Allen Memorial Award

Inspection Trips to Guggenheim Laboratories and Freeport, L. I.

Following the presentation of a paper by Major Geo. H. Gleason, describing "The Development of a Chemical Process for the Treatment of Sewage," between 140 and 150 members and guests of the Association visited the Guggenheim Laboratories to inspect the small sized but complete plant in operation. It was perhaps the first time that those making the inspection trip had experienced the thrill of being whipped in bus caravan on a non-stop run from 34th Street and Broadway to 202nd and Dyckman Streets behind police sirens and through red lights with motorcycle cops on all sides.

On the day following 50 members and guests made a trip of inspection (a post-convention arrangement) as the guests of the city of Freeport, L. I. The visitors were received and entertained by the City Engineer of Freeport, L. L. Luther. There they were shown a plant scale demonstration of chemical precipitation wherein ferric-chloride solution was being employed as the coagulant. The Freeport plant employs sedimentation chlorination and separate sludge digestion—ferric chloride also being used to increase the capacity of the glass covered sludge-drying beds.

L. L. Luther, City Engineer and Manager Sanitary Department, Freeport, L. I.

Joint Dinner Held

The Sanitary Engineering Division of the American Society of Civil Engineers hold annually a dinner preceding the meetings of the Society. For the past two years the New York State Sewage Works Association has been invited to hold its dinner jointly with the Sanitary Engineering Division. Over the joint dinner Professor Charles Gilman Hyde of the University of California presided as toastmaster.

Captain Stanton L. Dorsey, Sanitary Engineer of the U. S. Veterans Bureau, Washington, D. C., the speaker of the evening, presented several reels of moving pictures taken of German sewage treatment works during his recent stay on the Continent where he took special courses in Sanitary Engineering subjects.

New Officers Elected

The following officers were elected for 1933:

President—A. F. Dappert, State Department of Health, Albany, N. Y.

Vice-President—E. E. Besselievre, The Dorr Co., New York City.

Sec'y.-Treas.—A. S. Bedell, State Department of Health, Albany, N. Y.

New members named on the Executive Committee are:

Professor Henry N. Ogden of Ithica, N. Y.

Robert G. Wheeler, Cons. Engr., Albany, N. Y.

Edmund B. Besselievre, The Dorr Company, New York City.

Papers and Discussion

"Facts and Fancy in Sewerage Financing," by ABEL WOLMAN, Chief Engineer, Maryland State Department of Health, Baltimore, Md.

Mr. Wolman said that so much had been written during the past few years about financing sewerage that he felt that he should refrain from repeating some of the outstanding facts presented elsewhere in detail. He paid compliment to the excellent recent paper—"A Review of Sewer Rental Laws and Charges"—by Childs and Schroepfer in Sewage Works Journal, November, 1932. With this paper in mind, Mr. Wolman said that he would restrict his remarks to a discussion of the philosophy of financing sewerage systems, with particular reference to the psychology of the taxpayer in whatever plan of financing may be chosen. He thought the present difficulty with Municipal taxation, including the general property tax accounting for 65 per cent of all reve-

E. B. Besselievre, Vice President of the Association

*Kenneth Allen, Sanitary Engineer of New York City, was a founder and tireless worker in behalf of this Association.—Editor.

nue for local government, was not in its amount or its injustice but rather its inevitability and the impossibility of shifting it. Being payable in a lump sum payment annually, with penalties for delinquency, rather than in quarterly or monthly sums stresses the hardship. To avoid the unpopular property tax there had been a rush recently to the rental method of raising funds, not only because it was equitable and more frequent in billing and more closely linked with service supplied, but because property taxation has psychological and fiscal disadvantages. In sewerage construction such disadvantages were now more pressing than ever. The alternatives available should be considered primarily from the standpoint of logic and equity, rather than from temporary expediencey and popular hysteria, even though such hysteria be reinforced by ill-advised legislative fiat.

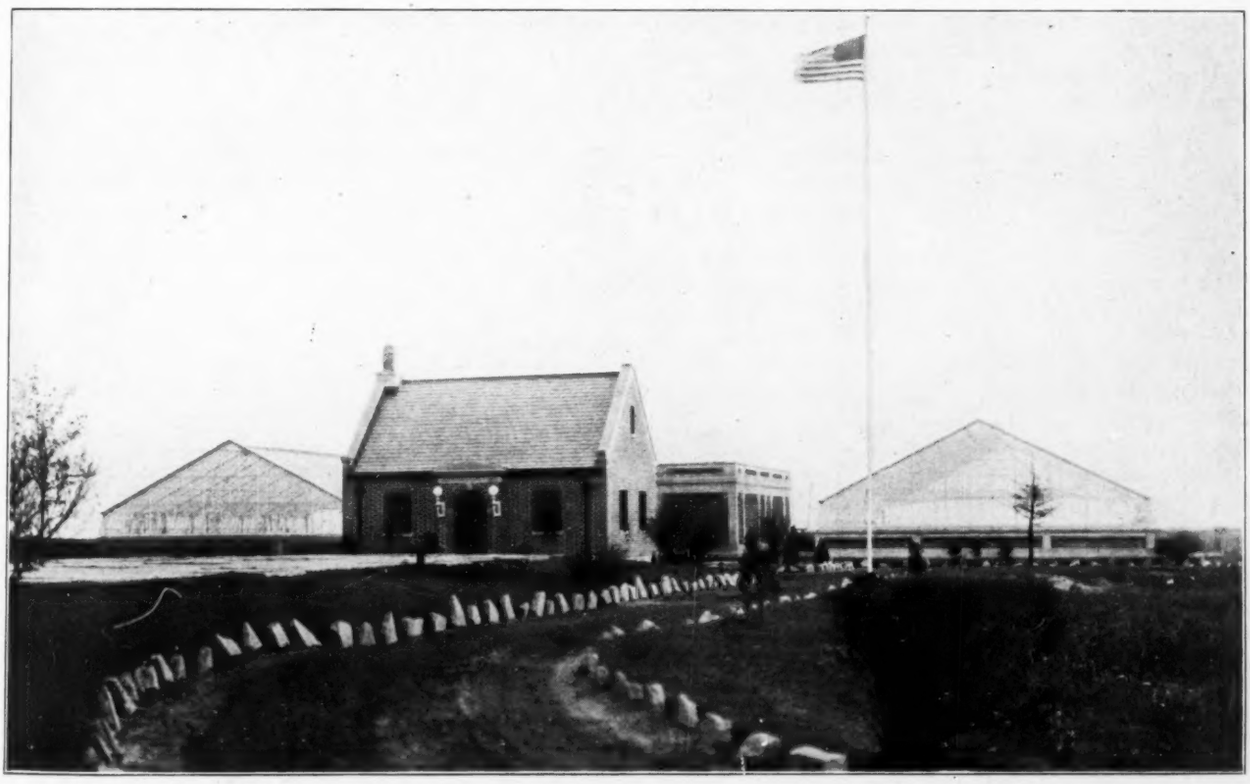
In commenting on the basic principles of financing sewerage systems, Mr. Wolman reviewed the theoretically ideal program which had been put forth by Morse and Wolman in their article, "A Plan for Meeting Water Supply and Sewerage Costs," in Engineering News Record of June, 1921. He said that the validity of the plan had been proven by the test of time and during its application in Maryland. Fundamentally, the plan had been based upon the principle that public and private benefits should be separately considered and that there should be a differentiation between fixed and operating charges. The plan embodied the payment for sewerage systems by a combination of property tax, annual front foot assessment, house connection, cash payment and a service charge. The capital cost was to be met by the tax rate and front foot assessment: The expense of operation and maintenance to be derived mainly, if not wholly, from charges for service rendered, i.e., sewer rental.

The plan formulated for the Washington Suburban Sanitary District had worked well—the front foot assessment being 12 to 16 cents and service charge from $4.00 to $6.00 per year. In other instances it had had to be altered somewhat to satisfy sectional prejudices or local objections and the latter frequently holds. The wisdom of the specialist and the wish of the people will require some "give and take," in order to attain the most workable, if not the most correct, scheme of financing, but he cautioned the former not to be too much influenced by the expediency of the moment.

GEORGE W. FULLER in complimenting Mr. Wolman on the suggestions contained in his early paper of 1921, and now amplified, said that the experiences of the Washington Sanitation District and of Hagerstown, Md., had proven their soundness. He thought that with whatever scheme might be proposed, educational work with the taxpayers was a highly important matter not to be under-estimated.

In reply to a question as to what system of rental is proposed, Mr. Wolman said, that the metered water was used as the index where water works and sewerage comes under one head. Otherwise, a graduated rental, based on a study of the property and water usage, would be applicable. In addition to rental, some portion of the annual assessment should go toward paying fixed charges on the treatment plant. The R. F. C. insists that front foot assessments must be considered as taxation but Maryland communities differ with this and they feel that the Relief Act of 1932 thereby needs adjustment.

H. C. DELSELL, Engineer of the Portland Cement Association, presented some of his recent experiences in sewerage financing, while serving the National Committee for Trade Recovery, in 27 states—all of which have presented or will present sewer rental acts to the legislature. They had found the general tax out of favor and rental to be the most equitable means of financing. Changes in assessed valuation of property would defeat the program of financing through the general tax. Furthermore, in some communities a survey had shown only 9 per cent of the water bills to be delinquent whereas 40



Sewage Treatment Works at Freeport, L. I. (N. Y.). Sludge Digestors Show in Rear of Laboratory and Office Building Between the Glass Covered Sludge Beds. Settling Tank in Left Foreground. Ferric Chloride Feeding House (not shown) Is on the Reader's Left.

per cent of the general taxes had not been paid—indicative of the soundness of the rental plan of financing.

MR. WOLMAN had not found tax delinquency to be so high in Maryland and he called attention to the higher costs of financing through revenue bonds than through tax obligation bonds which had incidentally been the more secure—even including those of Chicago. MR. DELSELL replied that revenue bonds were suggested only when the power to issue general taxation bonds had been exhausted.

C. H. CAPEN, Consulting Engineer, Orange, N. J., suggested that we could profit by studying privately owned and operated sewerage systems. Charges for sewer rent were about the same as for water service. Municipal charges for sewer service had been about the same as those of private companies but only where assessment on property had been excessively high.

MR. WOLMAN replied that on the whole he had found private rates consistently higher than municipal rates.

"Explosion and Health Hazards in Sewage Works Operation," by G. W. JONES, Chemical Engineer, U. S. Bureau of Mines, Pittsburgh, Pa.

To report Mr. Jones' paper adequately is difficult. This primarily because of the inability to reproduce in type the valuble demonstrations of explosions and flame propagation which were vividly enlightening. He reviewed the causes of explosions and means of prevention. He demonstrated the intensity of explosions as being a function of the ratio of gas or vapor to the air in the mixture. Further, the thoroughness of mixing of the oxygen bearing air with the flammable substance was shown to have its bearing on the travel of flame and degree of explosiveness. In long glass tubes one was given a visible demonstration of how, depending upon conditions, flame might travel at great velocity or relatively slowly, up sewers. When the proper ratio of air to the burning gas was encountered along the course of flame travel there the explosion occurred. In sewers, Mr. Jones said, that would usually occur in the vicinity of vented manholes. It was plain that the point of explosion might lie hundreds of feet to miles away from the point of the gas or vapor ignition. The value of the "flame fence" across a pipe line to arrest flame travel was demonstrated. In this case a wire screen of 40 meshes to the inch placed across the diameter of the tube (pipe) checked the flame travel, i.e., the flame could not penetrate the 40 mesh "fence" when traveling at *moderate* speeds. High speed flame travel, Mr. Jones warned, could not be arrested by a single arrester (screen) and several in series would be required. As the most valuable defense against flames reaching a gas holder or sludge digestion tank, Mr. Jones advocated the use of pressure release diaphragms augmented by water-seals and wire screens.

Asked to suggest the proper arrangement of traps and seals, Mr. Jones said that release diaphragms should be made of sheets of aluminum, lead or tin foil of 0.002 inches thickness. The clear opening sealed by the diaphragm should be *not less than* 6 in. in diameter and should have 3.5 square feet of opening area for each 100 cu. ft. of gas passing through the flame trap. This would stand pressures to 12.5 lbs.. per square inch. This recommended that two flame traps with screens and a release diaphragm in parallel be installed and these normally operated in series except when one might be bypassed for inspection repairs, etc.

Perhaps one of the most startling demonstrations made by Mr. Jones was that of igniting a highly flammable gas (carbon bisulphide) by introducing a hot, but not visibly red, glass rod in the vapor—the ignition temperature being 120 degrees Centigrade, or scarcely more than that of boiling water. Hydrogen sulphide gas, he said, would ignite at between 346 and 379 degrees C. but methane would require an appreciably higher temperature to ignite, viz., 645 degrees C. Ammonia gas would burn when raised to 780 degrees C. Gas from sludge digestion would ignite at a temperature lower than 645 degrees C. but higher than that for hydrogen sulphide, i.e., above 375 degrees C. The more of the latter that sewer gas or sludge gas contained, the lower would be the ignition temperature—other things being equal. He said that gasoline vapors would not burn unless these were mixed with 12 per cent or more air, that there would be no gas explosions if air were completely excluded from the system or tanks in which gas is being generated.

DR. R. R. SAYERS, Chief Surgeon, U. S. Bureau of Mines and Surgeon of the U. S. Public Health Service, was the principal discussor of Mr. Jones, paper. Dr. Sayers, in dealing with health hazards at sewage works, said that methane gas when present to the extent of 6 to 8 per cent in the atmosphere would make breathing difficult and twice that quantity would create distress whereas 30 per cent would cause rapid death.

Hydrogen sulphide, he said, was the thief in the dark because of its deadly nature and the fact that in death dealing concentrations it could not be detected by smell because it had a deadening effect on the sense of smell. Experiments had shown that an animal, as large and as tough as a goat, might stand a concentration of 0.05 per cent with dislike but that raising the concentration by only 0.01 per cent to a total of 0.06 per cent the goat would drop as if paralyzed and stop breathing. By *prompt* removal from the chamber, the animal could be revived and the experiment repeated. Hydrogen sulphide poisoning was fortunately not of the cumulative variety but continuous breathing of as little as 0.005 per cent in the air should be considered as bad. A man might stand ten times that concentration (0.05 per cent) for some minutes but between 0.07 and 0.10 per cent produced acute poisoning and death.

Carbon monoxide was not important around sewage treatment works but was important in sewers because of artificial gas leakage into these. A man could stand 0.02 per cent and as much as 0.1 to 0.2 per cent of this gas for a period of 30 minutes.

Measures of prevention of accident, resulting from poisonous gases or lack of oxygen in a sewer, pit or tank, should consist of testing before entering. Some small animal might be exposed to determine whether the atmosphere was safe. Of all the safety masks used the hose type with air intake outside would be the most efficient. Canister masks would remove poisonous gases but where there was a deficiency of oxygen, ventilation or the use of the hose mask was essential. He recommended that men should always work in pairs and that the man entering be attached to a rope with preferably two men available to pull the worker up to air should he need help. In reviving a worker the use of the Shafer method of artificial respiration was advocated because of its simplicity. Nothing should be administered internally and the patient should be kept warm and in a prone position until a physician could be secured to shoulder the further responsibility of treatment.

Chemical Treatment of Sewage

"The Development of a Chemical Process of Sewage Treatment," by MAJOR GEORGE H. GLEASON and A. C. LOONAM, Chemical Engineers, Guggenheim Brothers, New York City.

Major Gleason in presenting his highly interesting

paper describing a novel chemical process of sewage treatment which had been developed in the Guggenheim Laboratories during the past year, reviewed the numerous lines of attack which had been investigated before making a final selection of a process which incorporates chemical precipitation with an iron coagulant and lime followed by sedimentation and filtration of the effluent through zeolite beds to remove the nonsettleable flocculated matter and the ammonia from the effluent. The sludge from the clarifier was being dewatered on a vacuum filter prior to complete and odorless incineration. The iron remained in the incinerator ash and was subsequently recovered. Recovery of the coagulant (iron) was being brought about by digestion of the ash with sulphuric acid, which process yielded ferric sulphate and acid in solution ready for reuse. The ammonia, plus the amine compounds, removed by the zeolite was recovered by regenerating the zeolite with brine solution as was common practice in water softening. The liquor containing ammonia salts when alkalinized with lime would yield ammonia upon distillation by a process commonly used for such purpose.

Major Gleason said that comparative experiments leading to the selection of a ferric salt had demonstrated that ferric sulphate in conjunction with lime had produced settling rates about twice that of aluminum sulphate—the iron being added prior to the lime proved to be an important consideration. The zeolite used was selected as being a preferred type in ammonia removal as revealed by experimentation. Sand filters ahead of the zeolite beds had been discontinued after demonstrating the nonessentiality of these units. Agitation of the sewage for 5 minutes with air (0.07 cu. ft./gal.) following introduction of the iron had been used to preclude reduction of ferric to ferrous iron. The dosage of ferric sulphate found to be ample amounted to 30 p.p.m. iron—i.e., 105 p.p.m. of ferric sulphate $Fe_2(SO4)_3$. (Based on iron content 105 p.p.m. ferric sulphate is equivalent to only 85 p.p.m. ferric chloride.—Ed.) The iron had been effectively precipitated at pH values of 5 to 6.5 and then followed the lime and perfected flocculation, employing a "flocculator." The pH values throughout the system had been maintained between 6 and 8 to produce maximum settling rates and optimum operation of the zeolite beds.

The Portable Experiment Plant, Set Up at the Guggenheim Laboratories, Preparatory to Shipment to Chicago. Capacity 25,000 g.p.d.

Major Gleason reported that precipitation and clarification alone had removed roughly 60 per cent of the putrescible matters and almost 50 per cent of the nitrogenous materials—leaving a total of 15 p.p.m. in the effluent going to the zeolite filters of which 12 parts had been present as ammoniacal nitrogen. Suspended solids passing through the clarifier had averaged but 10 p.p.m. as compared with 269 p.p.m. average in the crude sewage. The area of the clarifier used was such as to produce a rate of 800 gals. per sq. ft. of surface area per day.

No rates of filtration through the zeolite beds were quoted by Major Gleason but the amount of zeolite required was estimated at 16,000 lbs. per million gals. of sewage treated per day and the rate of loss of zeolite at 5 to 7 per cent per year—notwithstanding the organic nature of the liquid filtered. The beds have had to be regenerated after 10 to 12 hours of service—using 20 per cent salt brine. After distillation of the ammonia and amines from the brine it is returned for reuse in bed regeneration—the amount of back wash of the beds being 1 per cent of the sewage treated. Ammonia recovery had amounted to 100 lbs. (NH_3) per million gallons when dealing with the clarified effluent containing but 14 parts per mission of ammoniacal nitrogen.

As to the quality of the final effluent, vs. the crude sewage dealt with, the following average figures were quoted by Major Gleason. The B.O.D. value had been reduced from 150 p.p.m. to 5 p.p.m.; suspended solids from 200 parts to 1 part. Total nitrogen had been reduced from 26 parts to 3 parts (roughly 90 per cent) and ammonia nitrogen to 1 part from 13 parts.

As to sludge dewatering and incineration, the wet sludge from the clarifier had been reduced from 93 per cent moisture content to between 70 and 75 per cent on vacuum filters where the rate of filtration had produced 7 pounds of solids (dry basis) per sq. ft. of filter surface per hour. The cake passing through an incinerator received drying in the first section and burning in the second at temperatures between 650 and 750 degrees Centigrade. By colorimeter test the dried sludge cake has a heat value between 4,500 and 5,000 B.t.u. per pound—sufficient to render incineration "self supporting." Maintaining a temperature of 600 degrees C. or above no odor nuisance is produced.

The ash containing 41 per cent of ferric oxide; 24 per cent of silica; 8.7 per cent aluminum oxide and 8.6 per cent oxides of lime and magnesia is digested with hot sulphuric acid to recover the coagulant for reuse. The residue from the acid digester is washed and discarded.

In commenting on predicted costs, Major Gleason said, from their estimates a plant of the type described could be constructed on an area roughly one-half of that required for accepted types of plants capable of producing about the same degree of purification—in this he had assumed an activated sludge plant to require 11,000 sq. ft. per million gallons of capacity. The cost of a plant of 50 m.g.d. capacity would be about two-thirds that of an activated sludge plant of like capacity if employing the prevailing basis of design and requirements.

The cost of maintaining and operating such a plant, using the chemical process, would be about $22.00 per m.g., exclusive of interest and amortization. Credit from the sale of ammonia recovered had not been given any value in estimating operating costs.

Major Gleason said that the experimental plant* had been operating 24 hours per day for a period of 8 months on New York City sewage taken from the Dyckman Street outfall. Seasonal variations had been covered

*For an illustrated description of this plant with more detailed operating results than here given, see WATER WORKS & SEWERAGE for December, 1932.

and they now felt the operating data to be conclusive. A larger experimental plant was ready for shipment to Chicago for further studies there.

Dr. Willem Rudolfs, Chief of the Department of Sewage Research at Rutgers University, in discussion, brought forth several very pertinent questions concerning the process above described. He referred to the increasing complexity of the biological processes and the renewed future of chemical precipitation processes, largely brought about by advanced technic of control and improved mechanisms available in the sewage field for sludge handling, etc. The fact that chemical treatment is odorless and not attended by the other nuisances renders it of considerable interest to all concerned. He felt the paper by Major Gleason and Mr. Loonam to be stimulating. He said that the removal of nitrogenous matters from the effluent had particular advantages because objectionable algae growths which would appear in streams receiving oxidized nitrogen in biological effluents would not be a factor in disposal of the chemical effluent.

The results when considering the removal of oxygen consuming elements, had been so excellent as to be subject to some doubt concerning the laboratory technic. He believed less success would come from handling a septic sewage than was had when dealing with the fresh Dyckman Street sewage largely of domestic origin. He thought the recovery of ammonia and iron coagulant added complications and wondered how many men would be required to operate a 5 m.g.d. (or less) capacity plant—there were 375 such plants in New Jersey. Would such plants benefit to any appreciable extent, if at all, by attempting recovery of ammonia or regeneration of the coagulant? If the ammonia removal was supplanted by filtration through sand what would be the reduced cost of the plant and operating costs? He inferred that in many instances the ammonia removal could be disregarded and an attractive filtered effluent would be sufficient to meet requirements.

Dr. Rudolfs said that the ferric sulphate requirements seemed rather high and he wondered why the sulphate had been chosen in preference to some other iron salt—the chloride for instance?

Unfortunately the trip to the Guggenheim Laboratories had been arranged to start promptly on schedule time and the lack of time precluded a reply by Major Gleason and additional discussion which would have followed as evidence by the attendance at this session and the growing interest in what is the "oldest of the new" in the sewage treatment field. It is hoped that Messrs. Gleason and Loonam will find opportunity to reply in the pages of the technical press to the important questions propounded by Dr. Rudolfs.—*The Editor.*

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The 15th Texas Water Works Short School

The fifteenth annual Texas Water Works Short School was held in Temple, Texas, January 16th through the 18th with approximately 100 attending. Meeting in conjunction with the Short School, was the Texas Section of the Southwest Water Works Association.

Salt Water Problem in Texas

The problem of contamination of streams by salt water and oily wastes from oil-well fields has become of increasingly serious proportions in Texas. This situation led to the recommendation of the Committee on Stream Pollution, (L. O. Bernhagen, Chairman), that a legislative act should be drawn to stipulate therein the limits of permissible discharge of salt water, or other wastes injurious to water supply, into fresh water streams of Texas.

Certification of Water Supplies

The Committee on Certification of Water Supplies presented a report endorsing the standards set by the U. S. Treasury Department which must be met consistently before a water supply is certified for use on interstate carriers. The report approved the additional State Department of Health requirements to be met before certificates are recommended by them, viz.: elimination of hazardous cross connections; regular monthly bacterial reports to the Department; and regular monthly operation reports in addition.

The committee called attention to the desirability of a similar if not identical requirement which could be applied to all public water supplies in the state, regardless of whether they be the source of supply for interstate carriers or not. In this manner, it was thought, small towns might be offered an incentive and could be given credit for improving their water supply and for maintaining it on a high level of safety. A further recommendation was that the State Department of Health give consideration to making mandatory the filtration of all surface waters that show the presence of visible biological forms intermittently, even though the bacteriological analysis should reveal no disease producing organisms present.

Operation and Rating Standards to Be Set Up

The Committee on Operation and Rating Standards, (J. Bryan Miller, Chairman), presented a report which was considered as the outstanding feature of the meeting. After extended discussion the following points were favorably voted on and the plan will be executed:

(1) A board consisting of four members is to be appointed by the President consisting of a representative of the Bureau of Engineering, State Department of Health; two superintendents of water departments and one engineer at large.

(2) The duties of the Board will be to classify the public water supplies of Texas; to provide a system of licensing of water works operators and to arrange for the standardization of highway signs showing the approval of the municipal supply by the State Department of Health.

Symposium on Sewage Treatment

One feature of the Short School was a Symposium on Sewage Treatment at which papers were presented by W. S. Stanley, Chemist and Superintendent of the San Antonio Sewage Treatment Works, and Clyde C. Hays, Chemist in Charge of the Treatment Works of Waco, Texas.

Because of lack of space in this issue, these and other important contributions during the meeting will be reported in digest form in Water Works and Sewerage for March.

New Officers

The following new officers of the Texas Section of the S. W. W. A. were elected for the ensuing year:

President—D. T. Mauldin, Munday, Texas; Vice-President—Albert Davis, Austin, Texas; Vice-President—L. C. Billings, Dallas, Texas; Secretary—V. M. Ehlers, Austin, Texas; Editor—Ella G. White, Austin, Texas.

BLEACHING CLAY IN WATER PURIFICATION

By GEO. D. NORCOM

Sanitary Engineer, Federal Water Service Corporation, New York City

Geo. D. Norcom

DURING the past few years important developments have taken place in the field of water purification in the control of tastes and odors. One of the most important of these developments has been the use of material in the process of treatment capable of absorbing, or adsorbing, and thus removing substances responsible for taste and odor in the water supply. Activated carbon has been used widely for this purpose and has proved very satisfactory in a large number of water purification plants.

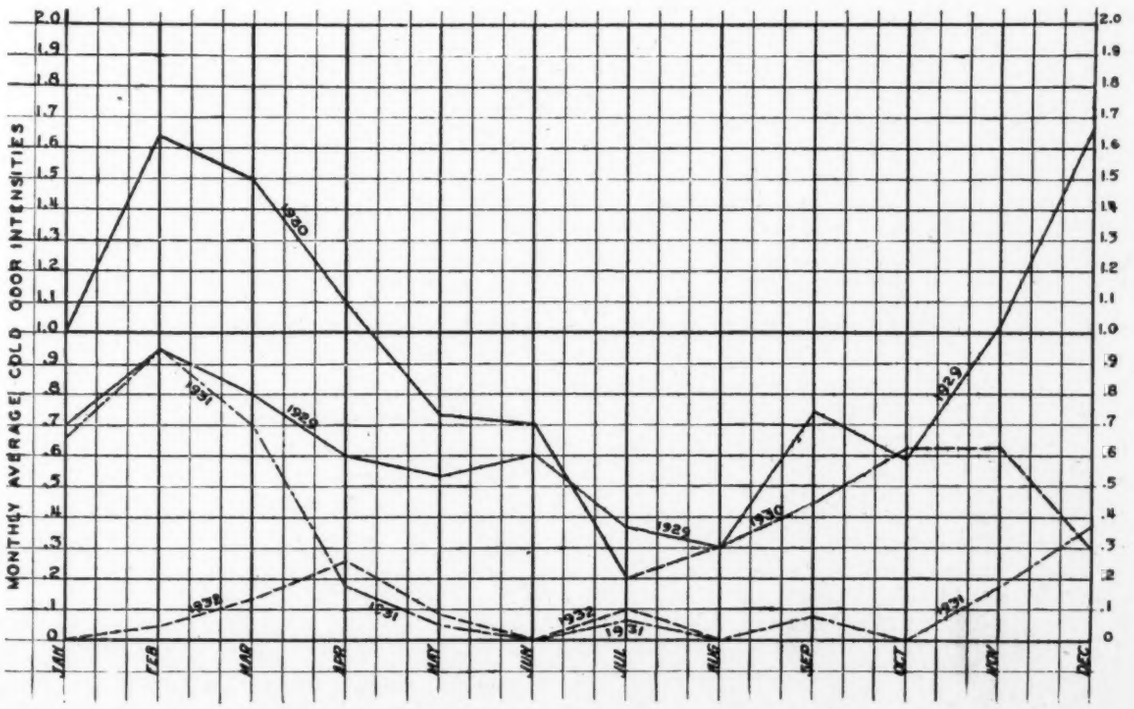
The problem of taste and odor has always been a serious one in the water supply of Chester, Pa. Chester secures its water from the Delaware River, some distance below Philadelphia. The region above Chester is one of the most highly developed industrial centers in the United States and the river receives a large amount of industrial and domestic wastes. From the point of view of taste and odor production, the wastes from oil refineries, gas and coke plants are the most serious.

For a number of years the Chester plant has been the scene of active experimentation in an attempt to discover a process, or combination of treatments, which would entirely eliminate taste and odor from the finished supply. The plant was recently modified to include aeration through nozzles, intensive pre-chlorination, and improved chemical feed and mixing. These modifications produced a marked improvement, but even with this combination of treatments taste and odor were frequently present in the finished water, especially during cold winter months.

Filtration Plant, Chester, Pa. Part of the Aeration and One of the Chlorine Contact Tanks Are Shown

Among the numerous experiments tried at this plant in the fight to control taste and odor, was the application of powdered activated carbon. This material was applied at various points in the process, and considerable benefit was obtained, but large quantities of the carbon were required for the complete elimination of the undesirable taste and odor, and the use of such quantities was not only expensive but interfered to a considerable extent with filter operation.

In the fall of 1931 another substance for use in water



Average Intensity of Cold Odor in Treated Water. Results from Improved Plant Shown in Broken Lines

treatment, for the removal of taste and odor, came to our attention. This material is known as "bleaching clay." It is a finely divided silicate of a bulky nature, having a light yellowish color. This bleaching clay has been widely used in the purification of various oils and its use in water treatment is not new. The addition of clay to clear waters for the promotion of flock formation with alum, and for decolorization, has long been practiced. The value of bleaching clay for the removal of taste and odor producing substances in water is not so well known.

Laboratory experiments with this material were first made on raw water from the Delaware River, which had an odor designated as "5 oily." It was found that the bleaching clay removed this odor to a major extent. The next step was to repeat these experiments on a plant scale, and when this was done the laboratory experiments on odor removal were not only duplicated, but it was noted that improved results in color removal and flock formation were obtained.

As a result of these experiments, a shipment of the bleaching clay was secured and its use was commenced as a regular part of the purification process. After some preliminary experimentation, it was found that best results were secured with the clay by introducing it into the raw water *before* aeration. The bleaching clay, when so applied, seems to have a marked capacity for removing taste and odor due to oil refinery waste.

The use of bleaching clay was commenced in Chester late in December, 1931, and the process has been continued in use up to the present time. The doses applied vary from 0.10 to 0.80 g.p.g. and the average amount applied has been 0.34 g.p.g.

The effect of the bleaching clay on taste and odor in the Shester water supply is clearly indicated on the accompanying graph. The effect of the treatment is particularly noticeable during the first three months of 1932. This is the period when tastes and odors in the raw water are most intense. During the entire year of 1932, the average odor intensity in the treated water has not exceeded a trace.

In addition to the benefits which have been derived from the use of bleaching clay with regard to taste and odor removal, other important benefits have been observed: First, the clay aids materially in forming a higher gravity flock with alum and the flock so formed appears to be stronger and more adsorbent. Second, the bleaching clay is capable of adsorbing chlorine, and the chlorine so adsorbed is carried to the bottom of the settling basin and exerts considerable influence in preventing the decomposition of the precipitated impurities in the water. This effect is noted particularly because there is not so much odor in the settled sludge as there was before bleaching clay was used.

Our experience with bleaching clay in water purification has been confined to the Chester plant, and only one kind of clay has been used, namely, Pikes Peak Bleaching Clay. We are not prepared to say whether other clays are available for this purpose, or whether they would be capable of producing similar results.

The cost of the clay used is roughly $16 per ton, f.o.b. Chester, Pa., from which it can be seen that the cost of the treatment, as applied at Chester, averages only 39 cents per million gallons.

The degree of success which has attended the use of bleaching clay as a step in the water purification process at the Chester plant, warrants the conclusion that this material is well worth the cost. Since the clay has demonstrated such marked capacity for adsorbing oils of a mineral nature, it will likely have a similar capacity for adsorbing vegetable oils such as the essential oils given off by certain kinds of algae. Further experimentation and trial is necessary however in order to determine the general applicability of this material to the general field of taste and odor removal from water supplies.

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Municipal Employees Shot for Grafting

Russia has a way of its own in dealing with grafters in municipal positions. A recent press dispatch from Sebastopol states that:

"Six employees of the city financial department today were sentenced to be shot for an 'economic counter-revolution' that took the form of large-scale grafting.

Headed by the first assistant chief, all the accused had been taking bribes in the form of produce and manufactured goods. The leader was sentenced to a year of hard labor and six others, including a woman, to varying prison terms."

The Russian method is certainly one effective way of disposing of the grafting problem and will meet the approval of the tax paying public.

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Correction

In the article on Railway Water Treatment appearing in the January issue of WATER WORKS AND SEWERAGE, it was noted on page 11 that the Southern Ry. used gravity slow sand filters at Spencer, N. C., and Monroe, Va. This statement was in error as the mud and hardness at both of these plants is removed in 2,500,000 gallon capacity concrete sedimentation basins. These plants are reported to give very efficient service, handling from 600,000 to 1,300,000 gallons daily under normal conditions. Sand filters and duplicate chlorinators are used at Monroe, Va., for drinking water supply only after the clarification and treatment for general service has been completed.

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Association Meetings Scheduled

Feb. 8—New England Water Works Association (Monthly Meeting). Hotel Brunswick, Boston, Mass. F. J. Gifford, Secretary, Community Water Service Co., Dedham, Mass.

Feb. 9-11—Kentucky-Tennessee Section A. W. W. A. (8th Annual Meeting). Brown Hotel, Louisville, Ky. F. C. Dugan, Secretary-Treasurer, 532 West Main St., Louisville, Ky.

March 8—New England Section A. W. W. A. (Annual Meeting). Hotel Brunswick, Boston, Mass. Roger W. Esty, Secretary, Supt., Water Dept., Danvers, Mass.

March 22-24—Canadian Section, A. W. W. A. Hotel Chateau Laurier, Ottawa, Ont. A. E. Berry, Secretary, care of Ontario Dept. of Health, Toronto, Ont.

March 28-29—Indiana Section, A. W. W. A. Hotel Anthony, Fort Wayne, Ind. C. K. Calvert, Secretary, Box 976-H, Route No. 3, Indianapolis, Ind.

April 4-6—Southeastern Section, A. W. W. A. Radium Springs Hotel, Albany, Ga. W. H. Weir, Secretary, Room 138, State Capitol, Atlanta, Ga.

April 21-22—Montana Section, A. W. W. A., to be held at Harve, Mont. Herbert B. Foote, Secretary. Director, Division of Water and Sewage, State Board of Health, Helena, Mont. In connection with the above, there will be held a two-day short school for water works operators, April 19th and 20th.

April 23-28—Oklahoma Water and Sewage Conference. A. & M. College, Stillwater, Okla. H. J. Darcey, Secretary, Chief Engineer, State Health Department, Oklahoma City, Okla.

May 11-13—Pacific Northwest Section, A. W. W. A., to be held at Bellingham, Wash. Ernest C. Willard, Secretary, 720 Corbett Bldg., Portland, Ore.

June 12-16—53rd Annual Convention of The American Water Works Association. Hotel Sherman, Chicago, Ill. Secretary, B. C. Little, 29 West 39th Street, New York, N. Y.

INDUSTRIAL WATER SUPPLY ·AND TRADE WASTES·

ACTIVATED CARBON IN INDUSTRIAL WATER PURIFICATION

By A. S. BEHRMAN
*Chemical Egineer**

MUCH has been said and written—and quite properly so—in the last three years regarding the use of activated carbon by the community for the removal of tastes and odors from its water supply. So much attention, in fact, has been given to the community phase of water treatment with carbon, that the quietly and steadily expanding utilization of this same development by industries is frequently overlooked. It is the purpose of the present paper to sketch briefly the really surprising results which the use of activated carbon has already accomplished in industrial water purification, and to suggest further fields for expansion.

Granular vs. Powdered Activated Carbon

In the early part of 1929 the writer's organization, in cooperation with the Darco Corporation, began the active commercial development in this country of the use of activated carbon in water purification. At the same time, Baylis[1] was making the first series of his classic experiments on the subject.

At this time our attention was concentrated on the granular form of activated carbon, to be used in the removal of objectionable tastes and odors from water merely by passing the water through a bed of the carbon, the removal being accomplished either by direct adsorption or in conjunction with superchlorination. This concentrated interest in granular carbon was due not only to the obvious simplicity of the method of using it, but also to the fact that for the first time a satisfactory granular product of high activity was available at a reasonably low cost. The product referred to is granular Hydrodarco, developed for us by the Darco Corporation.

Baylis' original work was also done with beds of granular activated carbon; and the reports of his experimental work have emphasized the simplicity and automatic functioning of this type of carbon treatment.

In 1930, at the St. Louis meeting of the American Water Works Association, Spalding[2] called attention to the advantages in the use of the powdered form of activated carbon for municipal water purification, particularly in cases of intermittent and relatively short periods of objectionable tastes and odors, and when for these or other reasons the expense of additional equipment or facilities for employing granular carbon could not be justified. While powdered activated carbon had previously been employed to a limited extent for water purification, particularly in the packing industry, and

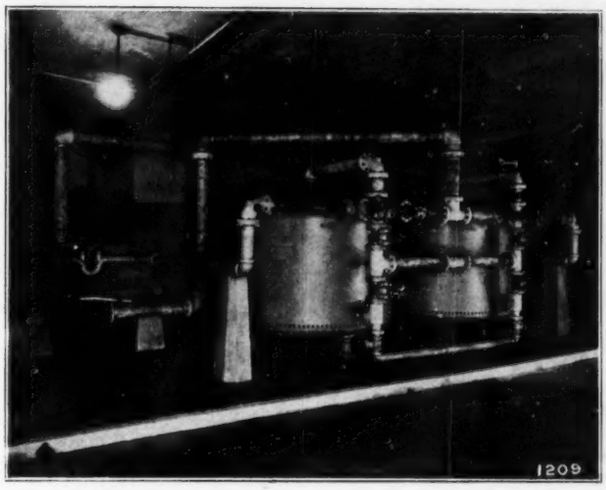

Fig. 1—A Battery of Two Hydrodarco Purifiers, Equipped with Rate Controller, in Large Chicago Canning Plant. Capacity 16,000 Gallons Per Hour

while several patents had already been issued in connection with the use of powdered carbon for large scale water purification, there is no doubt but that Spalding deserves the credit for popularizing the use of powdered carbon for municipal water purification in this country.

In the last two years the trend of water purification with carbon for community water supplies has been almost entirely toward the use of powdered carbon. However, the highly satisfactory results with a granular carbon installation obtained by Baylis in the Chicago experimental plant, and by Harrison[3] with the full scale plant at Bay City, Michigan, demonstrate very conclusively the possibilities of activated carbon in this field; and there is no doubt but that, as the waterworks profession becomes more "carbon-minded," and as the advantages and economies of granular carbon installations become better understood, there will be an increasing number of installations of this sort. The effective and economical method of reactivation of granular carbon reported by Mahler at the Pittsburgh (1931) meeting of the American Water Works Association is another and important step in the same direction. It seems equally certain, however, that the use of powdered carbon will continue to be popular in a great many municipal plants—possibly in the majority of them—for the reasons that have already been discussed.

Industrial Water Purification

In industrial water purification, on the other hand, conditions are such that only granular carbon installations have been found generally satisfactory. It is not difficult to see why this is the case: In the first place, water purification units in the typical industrial plant must occupy comparatively little space. Secondly, they must be substantially automatic in operation, requiring a minimum of attention; and third—and highly important in many cases—they must be operated under pressure.

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Because of these considerations, the standard activated carbon purifier employed in industrial water purification is a pressure unit, resembling in most outward aspects a conventional pressure sand filter or zeolite softener, but differing from them in several essentials of interior design and of operation.

The Field for Activated Carbon

Why is activated carbon employed for water purification in the industries? Partly for the same reasons as in municipal water purification, and partly for other considerations.

The principal purpose is to remove tastes and odors. Here obviously the goal is the same as that involved in municipal water purification, with the additional factor that the industrial activated carbon unit frequently has to remove the residual chlorine present in the water as a result of the community treatment. Other special applications of the carbon treatment are in connection with sterilization and with the removal of iron, color, and certain types of objectionable organic matter. A brief description of each of these uses will be in order.

Removal of Tastes and Odors

Since the principal purpose of activated carbon purifiers in industry is the removal of tastes and odors, it follows that this use will be applicable to any field in which the taste of the water used in the process is important. This is obviously true if the water becomes a part of the product, as in the beverage industry; it is also true if the water is used to wash the product, as in the washing of butter or of meat products. In certain special cases, even the water used for washing the glass or metal containers of especially sensitive food products must be absolutely free from objectionable taste or odor.

In no single industry has water purification with activated carbon been welcomed with as whole-hearted enthusiasm as in the beverage industry, particularly the "soft drink" field. The appeal—and consequent sale—of a bottled beverage is contingent largely upon its taste. It is not surprising therefore that the beverage industry has accorded a hearty welcome to such a simple and inexpensive assurance—and insurance—that the water, constituting such a large proportion of the finished product, will be above reproach in this most essential respect.

The enthusiasm of this reception by the bottling industry is attested by the fact that the first Hydrodarco Purifier for a bottling plant was installed in March, 1929. At the present writing there are several hundred similar installations.

The bottler has frequently received another and quite unexpected benefit from activated carbon purifiers. Certain waters foam very badly on carbonating; they do not "take" or dissolve the gas readily, and considerable gas is frequently lost in consequence. Presumably this foaming tendency is caused by the presence of certain types of colloidal organic matter[1] which are removed by direct adsorption in activated carbon. Regardless of the theory involved, it has been found in many cases that, after such a water has passed through a Hydrodarco Purifier foaming stops. Furthermore, water is carbonated quietly and with a material saving in carbon dioxide.

Other food product industries have also been quick to appreciate the value of activated carbon purifiers in providing a water supply that is blameless as to taste and odor. Especially noteworthy in a long list of installations in this field may be mentioned several in large food packing plants in the Chicago district; one for the most important "Chicken-a-la-King" canner in the world; and others for a wide variety of kindred services ranging all the way from the preparation of the tomato juice cocktail at one end of the menu to the chocolate syrup decorating the parfait at the other. In Fig. 1 is shown an installation of two Hydrodarco Purifiers in a large Chicago food packing plant.

Other Uses of Activated Carbon Purifiers

So far we have spoken only of the simplest way in which activated carbon is used in industrial water purification—that is, in a properly designed pressure unit containing a bed of activated carbon, in which removal of tastes and odors from the water takes place simply by passing the water through the purifier. In this case, the bed of carbon acts with remarkable and uncanny selectivity, taking out of the relatively tremendous mass of water the minute traces of taste-and-odor-producing impurities. In some cases, these adsorbed impurities are retained in the structure of the carbon—such is the case in particular with certain types of organic matter. In other cases, the adsorbed substance may react with the carbon. The most notable example of the latter situation is in the case of chlorine which, after being adsorbed by the carbon, eventually reacts with it and oxidizes it to carbon dioxide.

Clear Water a Necessity with Activated Carbon Purifiers

The water delivered to the activated carbon purifier must be clear. If the raw water supply is turbid, an efficient sand filter must be installed ahead of the purifier.

An activated carbon purifier can obviously function with greatest efficiency only when intimate contact is provided between the water being purified and the carbon. This contact cannot properly be maintained if the water contains appreciable amounts of suspended matter. Accordingly, it is standard practice to provide a sand filter ahead of the activated carbon purifier unless the influent water is initially clear. If the kind and character of suspended matter require it, a coagulant (usually lump ammonia alum or aluminum sulfate) is added to the water in an amount proportionate to the flow of water through the system; and in certain cases a reaction tank is inserted ahead of the filter to provide time for the formation of the floc prior to filtration.

A typical arrangement of this sort is shown in Fig. 2.

Sterilization

The same type of installation just described may also be used to insure the sterility of a water subject to occasional bacterial pollution. In this case, chlorine is fed to the raw water at the same point as the coagulant. Where large flows of water are involved, it is generally preferable to employ gaseous chlorine, applied to the water by means of standard devices made for that purpose. If the flows of water are relatively small, say up to 25 gallons per minute, it is usually more practical and economical to use a properly prepared solution of sodium or calcium hypochlorite. For these smaller requirements, the feeder shown at the extreme left in Fig. 3 is very convenient. This device consists essentially of a reservoir for the sterilizing (or coagulating) solution, and a small plunger pump actuated by a water meter, thus insuring a constant dosage of the water passing through the system, regardless of fluctuations in the flow.

In pressure installations of this sort, a total reaction time of at least 30 minutes is usually provided before the water reaches the activated carbon unit where the residual chlorine is removed. Ordinarily, the dosage of

chlorine is so regulated as to provide a residual of about one part per million of chlorine in the water as it enters the Hydrodarco Purifier.

Pressure sterilization installations of this sort have particular utility in the case of relatively clear waters known to be comparatively safe bacteriologically. They are especially applicable to deep well waters which are chlorinated chiefly as an insurance measure, and in the case of certain community or other water supplies when for some special reason absolute sterility is required by the user.

Fig. 2.—In Another Chicago Food Product Plant. Activated Carbon Treatment Preceded by Coagulation and Filtration. Alum Is Fed to the Incoming Water from Pressure Feeders in the Background. The Water Then Passes to the Large Reaction Tank in the Center, Thence to a Battery of Sand Filters and Finally to a Battery of Hydrodarco Purifiers

These pressure installations, with comparatively short reaction time, are not to be recommended in the case of a turbid or highly polluted water. In such cases the water purification process must proceed along lines akin to those followed in municipal water purification.

An installation for carrying out such processes effectively and economically is shown in Fig. 4. This is a gravity of "open" type of plant. Adequate coagulation —and practically independent of the character of the water—is provided through the use of aluminum sulphate and sodium aluminate. Sterilization is accomplished with sodium hypochlorite, which, being alkaline, can be supplied from the same solution tank as the sodium aluminate. A reaction and settling tank of four hours' holding time is usually provided, after which the treated water passes through first a sand filter, and then a Hydrodarco Purifier.

A gravity treating plant of this sort is applicable to a wide variety of industrial requirements, comprising as it does almost a complete miniature municipal water purification plant. The flexibility of control, and the variety of chemical reagents which may be employed with it, make this type of plant suitable for other special purposes in addition to clarification or softening and sterilization.

Removal of Organic Matter and Color

Organic matter may be the cause of a wide variety of objectionable features in the industrial use of water, although it does not follow that a water is necessarily objectionable because it does contain appreciable amounts of organic substances.

A yellow or light brown color in clear water is almost always due to organic matter. Objectionable tastes are also mostly caused by organic matter, with the exceptions of those due to chlorine and to hydrogen sulphide. In the beverage industry, as we have already noted, certain types of organic matter cause "foaming" of the beverage during and after carbonation.

The organic matter causing color in water is usually picked up from vegetation. The same source is accountable for some of the musty and "vegetable" tastes encountered in certain water supplies. A great many organic tastes and odors, however, are caused by the presence of living organisms themselves, or by the products of their metabolism. Included in this group are numerous species of the algae and other microorganisms which are becoming increasingly familiar to the water works profession. Organic in nature also are the phenols introduced into surface supplies through gas house and coke oven wastes. These phenolic substances give rise to powerfully offensive combinations when reacted upon by ordinary small sterilizing doses of chlorine, but are destroyed by the larger doses of chlorine employed in superchlorination.

In the removal of organic matter with activated carbon, much the same procedure is employed as has previously been described under sterilization. No definite rule can be laid down, however, since each problem must be thoroughly studied and decided on its own merits. A proper decision can be reached only after a careful survey of all the conditions involved, and preferably after confirmatory tests have been made in the laboratory.

In general, it may be said that we have three methods of removing offending organic matter: (1) Direct adsorption in activated carbon; (2) Adsorption in carbon following coagulation and filtration; and (3) Actual burning up of the organic matter with excess chlorine. Quite frequently a combination of two or three of these methods is necessary. The simplest case is the removal

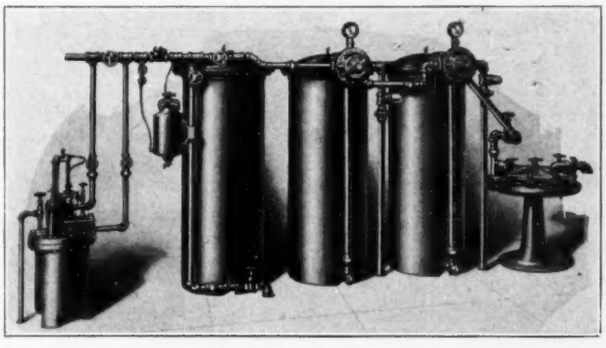

Fig. 3.—Complete Pressure Plant for Providing Chlorination, Coagulation, Filtration and Activated Carbon Treatment. From Left to Right: Hypochlorite Proportional Feeder, Coagulant Feeder, Reaction Tank, Sand Filter, Hydrodarco Purifier, Disk Filter. The Last-Named Unit Is Particularly Popular in the Beverage Industry for Giving a Final "Polish" to the Water

by direct adsorption in activated carbon; this is applicable only when the organic matter is present in relatively tiny amounts, as in the case of phenols, algae tastes, and concentrations of similar magnitude. Next in order of complication is the added use of a coagulant, either with or without the employment of chlorine. For this purpose the pressure installation pictured in Fig. 2 may be advantageously utilized.

When high color, or a considerable amount of other resistant organic matter in a water makes necessary the use of chlorine primarily as an oxidizing agent to "burn up" the offending material, then the gravity plant shown in Fig. 4 and previously described must be employed.

A number of such installations have already been made, and with gratifying results.

Iron Removal

A unique development in the application of activated carbon to industrial water purification is in connection with chlorine used in conjunction with pressure installations for iron removal. This process, which is covered by pending patent application, depends for its success on the fact that if a water containing ferous iron in solution is treated with an excess of chlorine, the ferric compound which results is hydrolyzed almost instantaneously, with the liberation of insoluble ferric compounds including the hydroxide, which can then be removed by filtration.

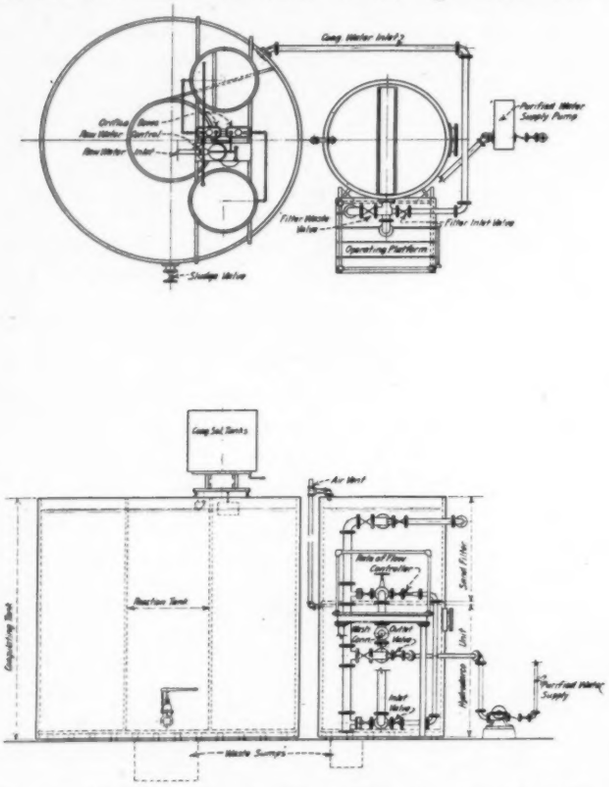

Fig. 4.—"Open" or Gravity Type Plant for Providing Same General Variety of Treatments as Pressure Plant Shown in Fig. 3, But with Considerably Wider Field of Application

Iron in objectionable amounts is found chiefly in ground waters, which are devoid of oxygen. The common method of removing iron is to aerate such a water to oxidize the iron, and then filter it to remove the insoluble ferric hydroxide thus produced. In doing so, however, the water becomes substantially saturated with oxygen and may—particularly with waters of low pH—be rendered highly corrosive to the distribution system, and thereby cause the water to acquire more iron from the pipes than was present in the first place.

By employing the new closed process just described—and substituting chlorine for aeration—the iron is removed without the introduction of any oxygen. Further, the fact that the system is a closed one obviously eliminates the necessity for repumping.

Two highly successful installations of this sort have already been made—one for a large estate in Florida, the other for an important cannery on the Atlantic Seaboard. The first of these is shown in Fig. 5. Chlorine is introduced into the line by means of a Wallace & Tiernan variable rate chlorinator. A coagulant is introduced at the same point. The water then enters a 30-minute retention tank, after which it flows through pressure sand filters and finally through Hydrodarco Purifiers. As a result of this treatment, the iron is completely removed; the water is sterilized; and the taste of the water is much improved, not only because of the removal of the iron, but also because of the reduction of organic matter.

Other Forms of Carbon Treatment

There are several other modifications of activated carbon treatment which we have developed for special requirements in industrial water purification; but space will not permit us to go into the details of these processes at this time.

Life of Activated Carbon Purifiers

The active life of the carbon in a purifier will naturally depend a great deal on the use to which the carbon is put. The most common use of activated carbon units in industry is for the removal of chlorine, chlorophenols, and similar taste-and-odor-producing substances from water supplied by the community. With such relatively light duty, the life of the carbon will naturally be a great deal longer than if the carbon is used for the direct adsorption of organic matter from a highly colored water.

Some idea of the useful life of an activated carbon bed can be gained from the fact that we formerly guaranteed granular Hydrodarco to have a minimum active life of two years when used for removing tastes and odors from Chicago water—a water which has achieved wide notoriety because of its frequent affliction with these objectionable ailments. An interesting commentary on this guarantee is the fact that a number of installations have been in service in the Chicago area for three years or more; and it has not been necessary to replace the carbon in any of these installations. This record of long life is not confined to Chicago, but is the general experience throughout the country.

Fig. 5.—Pressure Iron Removal Plant on Large Florida Estate. An Excess of Chlorine Is Fed to the Water by the Vacuum Type Automatic Proportioning Chlorinator Shown in the Background, and Alum Is Fed from a Pressure Coagulant Feeder. The Treated Water Then Passes to a Reaction Tank to Permit Precipitation of Ferric Hydroxide, Thence to the Sand Filters Shown on the right, and Finally to the Hydrodarco Purifiers on the Left. Capacity 15,000 Gallons Per Hour

Since the cost of replacement, when this eventually becomes necessary, is in itself quite low, it is evident

that the maintenance expense of an industrial activated carbon unit is practically negligible.

The Brandt Patent

Coincident with our first industrial installation of a Hydrodarco Purifier, we were confronted with a most disturbing and interesting problem. This was the appearance in the effluent water of a large amount of iron oxide. Our Research Laboratory finally established the surprising fact that Hydrodarco—and other truly activated carbons as well—set up high differences of potential with steel and other metals and alloys. In all cases the activated carbon was found to be cathodic to the metal. This behavior explained the appearance in the effluent water of the iron complained of; it also pointed out the very evident danger that it was only a question of time before the activated carbon would become coated with ferric hydroxide, and before serious disintegration of the metal shell of the purifier would result.

Boneblack, wood charcoal, and other carbons previously employed in water purification do not set up this potential difference with metals— only true activated carbons exhibit this behavior. It is likewise only these true and highly activated carbons which have the great adsorption capacities for phenols and other taste-and-odor-producing substances which make them valuable for water purification work.

On the basis of this and other related investigations in our laboratory, a patent application was filed covering metallic water purification apparatus containing a bed of granular activated carbon in which a dielectric lining is interposed between the carbon and the metal shell. Shortly after our patent application was filed, a patent (U. S. No 1,781,314, November 11, 1930) covering the same invention was issued by the Patent Office to Millard Brandt, of the Darco Corporation. It was fortunate for us that this patent was the property of our associates, so that we have been able to utilize this very necessary constructional feature in pressure activated carbon purifiers.

Arrangements are now under way by which it will be possible for all recognized manufacturers of water purification equipment to secure a license under the Brandt patent for a nominal royalty.

Conclusion

While this paper has not attempted to exhaust the possibilities of activated carbon in industrial water purication, enough has been said, we believe, to indicate both that much has already been accomplished, and that there are other fields of usefulness still to be explored.

As is always true of a development that is more or less revolutionary, the introduction of activated carbon in water purification has alredy given rise to a variety of exaggerated claims, inferior materials, and inadequate design and construction. It has been the policy of our own organization, in sponsoring the commercial development of the use of activated carbon in industrial water purification, to move slowly, conservatively and surely; and we feel that as a result of this policy many a "black eye" has been avoided that a more pecipitous course of action would probably have occasioned.

References

[1]Baylis, J. R. The Activated Carbons and their Use in Removing Objectionable Tastes and Odors from Waters. Journal American Water Works Association. **21**, p. 787, June, 1929.

[2]Spalding, G. R. Activated Char as a Deodorant in Water Purification. Journal American Water Works Association. **22**, pp. 646-648, May, 1930.

[3]Harrison, L. B. Activated Carbon at Bay City's Filter Plant. Journal American Water Works Association. **23**, pp. 1388-1392, September, 1931.

[4]Heath, W. P. Water for Carbonated Beverages. Canadian Bottlers' Review, p. 7, July, 1932.

Continuous Water Chlorination Important

The water supply for the town of "A" was taken from a source which required treatment. Chlorination only was in use. The results had been satisfactory and no illness had been attributed to this water. A conditon arose, however, which changed this completely. One day the operator of the plant attempted to make a slight repair to the chlorinator. To do this he shut off the chlorine, but continued to operate the pumps and deliver untreated water to the municipal mains. This continued for about half and hour and the machine was again put into service. All went along as usual for a time, and nothing was thought of this lapse in the treatment, since similar shutdowns for short periods had been made before. In about ten days following this occurrence typhoid fever began to appear in the town. Investigation showed that every case had used the municipal water supply. The number of cases reached a total of 20, and the epidemiological study showed conclusively that only this water was common to all. As might be expected, chlorination had been stopped once too often, and contamination happened to be present when the repairs were being made.

In Canada a great many municipalities are dependent upon chlorinated water. The nature of the pollution in practically all of these supplies demand continuous treatment rather than intermittent application for so-called emergency conditions. Supplies of this type necessitate absolutely continuous operation of the chlorination equipment while the pumps are running. A moment's shut-down may be sufficient to produce serious results. Every operator should be thoroughly impressed with the necessity for continuous operation, and the application of the correct dosage. The man who operates a chlorination plant has the health and lives of the water consumers under his charge, just as the engineer who guides the train. No laxity or carelessness on his part can be tolerated. The operator who is unable to appreciate this danger can find little justification for his employment.

Emergencies in chlorination are certain to occur, and every operator should be ready to meet them. But running out of a supply of chlorine is no emergency; it is gross negligence on the part of those responsible for the supply of this chemical.

When a breakdown or stoppage occurs in a chlorinator, the pumps should be immediately stopped until the equipment can be repaired, or a temporary arrangement made for emergency operation. Facilities and spare parts for temporary use should always be at hand, and the operator throughly familiar with their employment. The damaged part, or the entire machine, can be bypassed and chlorine fed to the supply. This will, of course, not be so readily controlled, and may cause taste, but safe water can be secured in this way with careful attention and supervision. A further emergency measure consists in having a supply of hypochlorite of lime always ready, should the liquid machine refuse to function. A duplicate equipment is, of course, most satisfactory and affords an additional safeguard, especially where the pumps normally operate continuously. This latter safeguard is being taken more and more in these plants. It is a very worthwhile investment and insurance.—From the *Canadian Public Health Journal.*

MEETING OF THE SANITARY ENGINEERING DIVISION OF THE A. S. C. E.

A Digest of Papers Presented with Discussion

THE Sanitary Engineering Division of the American Society of Civil Engineers held but one session during the recent annual meeting of the Society in New York City, January 18 to 21, 1933.

Dr. Edward Bartow, Chairman of the Division, presided at this meeting and Professor Chas. Gilman Hyde, Secretary of the Division, had come on from California to officiate. The attendance at the single session, however, was better perhaps than at any in recent years.

Committee reports presented included that of the Committee on Filter Materials presented by J. W. Armstrong who said that the Committee had devoted its attention during the past year to studies of the size of sand for rapid-sand filters. In this, 15 cities had been coöperating.

The Committee on Water Supply Engineering Practice reported through Chairman Thos. H. Wiggin, who outlined the proposed work of this Committee and Secretary Hyde reported that additional data covering sludge digestion studies carried forward at the Grand Rapids, Mich., and Elyria, Ohio, plants constituted an Appendix to the exhaustive report of the Committee on Sludge Digestion presented by Chairman S. B. Greeley before the 1932 meeting in New York City.

Papers Read and Discussion

"The Manufacture and Control of Liquid Filter Alum"—by JAMES W. ARMSTRONG, Filtration Engineer, Baltimore, Md.

Mr. Armstrong described the process employed at the Montebello Filters, in Baltimore, Md., for manufacture of liquid alum (solution) and its application directly to the water through automatic feed controllers. He disclosed the difficulties encountered in manufacture and handling of syrup alum and revealed the remedies employed to overcome these. He said that the Baltimore plant had been the first to make syrup alum by the Hoover process. Costs of manufacture were also given.

At Baltimore, the bauxite was being ground very fine—98 per cent passing 100 mesh and 75 per cent passing 200 mesh sieves. As received, the crushed bauxite must meet the specification of 57 per cent or higher (dry basis) alumina content (Al_2O_3) with a penalty charged for lower percentages or should the moisture content be in excess of 2 per cent. The grinding of the ore is done in a Raymond four roller, high side, pulverizer operated by a 50 H.P. motor equipped with a Morse silent chain drive speed reducer. A 20-in. fan, operated by a 40 H.P. motor, sucks the powdered bauxite out of the pulverizer and delivers it to cyclone separators preparatory to conveying it to storage bins.

Weighing hoppers deliver it to the three alum boiling tanks, having a capacity of 19,800 gallons each, constructed of 5/16-in. steel plates. The lead lining originally placed in these tanks had been too light (10 lbs. to the sq. ft.) and had cracked after 2 years of service. The relining was done with new sheet lead of double the weight of the original, having a thickness of 3/8 inches. For handling the concentrated and diluted alum syrup lead or lead lined pipe and fittings had been substituted for cast-iron pipe lines formerly found satisfactory for solutions of ordinary filter alum of 2.5 to 5 per cent concentration. The 10 per cent solution of acid alum had been too much for cast-iron.

In making the alum syrup the proportion of the ingredients entering the alum boiling-tanks, to produce one ton of alum, had been the following: bauxite, 575 pounds; 60 degree Baume sulphuric acid, 1,120 pounds; water for dilution, 50 pounds. To the water in the alum boiling-tanks the contents of the acid measuring tank are discharged. Immediately to the diluted acid (hot from chemical reaction) about 1,000 pounds of bauxite is admitted and a few minutes thereafter boiling becomes violent. On quieting down another volume of bauxite is admitted with renewed boiling resulting. The procedure is repeated until all of the bauxite (4,350 lbs.) has been admitted. Foaming and boiling had been controlled by air or water additions. The time required for completion of the conversion of bauxite to alum had been roughly 90 minutes—after which the syrup is diluted so as to contain 10 per cent aluminum sulphate ($Al_2SO4_3 : 7H_2O$) and subsequently to a 2 per cent solution prior to feeding. Each batch put through represented 8 tons of alum production.

For controlling the feeding of the final solution an automatic discharge nozzle had been developed by the Simplex Valve and Meter Company.

In arriving at the cost of producing the alum, Mr. Armstrong quoted figures in terms of dollars per ton of alum produced:

For Sulphuric acid*	$6.20 per ton
For Bauxite*	4.20 per ton
For Repairs (labor and materials)	1.21 per ton
For Fixed Charges**	1.94 per ton
Total	$13.59 per ton

*Materials costs had been Bauxite at $14.76 per ton and Sulphuric Acid (60 degree) at $11.08—both in storage at the plant ready for use.

**Certain equipment costing $16,040 is being depreciated at 5 per cent per year. Other equipment which had cost $12,280 is being depreciated at 25 per cent per year. Total depreciation being $3,872 for 2,000 tons manufactured, amounted to $1.94 per ton. The lead lining of the tanks had cost $5,384. The equipment required in pulverizing, separating and delivering the bauxite to storage had cost $10,780.

Mr. Armstrong said, that if they deducted savings effected through the reduced plant personnel made possible in syrup alum manufacture, a saving of three men ($3,942.00 per year) could be credited to alum manufacture, thus reducing the cost per ton to $11.62.

F. W. GREEN, Superintendent of Filtration at Little Falls, N. J., in discussing Mr. Armstrong's paper, said that at Little Falls cake alum was being produced in 4 ton batches. Their cost had been equivalent to $16.40 per ton of alum. They had struck upon the expedient of adding soda ash to the yrup before discharge to evaporating pans. That had increased the temperature and improved the quality of the alum cake. In this manner some sodium aluminate was produced in the basic alum cake.

H. N. JENKS, formerly Superintendent of the Sacramento, Calif., filtration plant and now Professor of Sanitary Engineering at the University of North Carolina, in a written discussion presented by H. G. Baity, said that the same difficulty with failure of lead tank

linings had been experienced at Sacramento, necessitating relining with very heavy lead. For solution lines he recommended chemical-lead or rubber hose up to 3 inch diameter and for larger sizes lead lined cast-iron. "Duriron" cocks and plug valves had been very satisfactory.

T. D. SAMUEL, JR., Chief Engineer and Superintendent of the Water Department at Kansas City, Mo., reported a cost of $16.90 per ton of cake alum manufactured at the Kansas City plant.

"Deep Tunnel Delivery of Water Supply for Large Cities"—by W. E. SPEAR, Department of Engineering, Board of Water Supply, New York City.

Mr. Spear enumerated the peculiar advantages that pressure tunnels, for water-supply delivery through large cities, have over pipe lines. Among them was less expense than that entailed in providing a group of pipe lines having the same carrying capacity as a tunnel. In New York City a pipe of 66 inch diameter was the largest that could be laid without interference with other underground structures and conduits. Deep tunnels (500 to 600 ft. depth) had the advantage of not interfering with surface operations and 25 foot rights of way had cost the city but 2 cents per running foot. Tunnels under pressure should be steel lined through soft ground, with shafts 1 mile apart. Rock tunnels require grouting. Covering over the crown of tunnels should be not less than 50 feet, 150 feet being much sounder practice. Cement lining is always necessary and the shape should be circular.

Mr. Spear said that New York's pressure delivery tunnels were 15 to 17 ft. in diameter and had a concrete lining 15 to 19 in. thick. In general, he wished to repeat that deep pressure tunnels could be justified only in the largest cities. They are permanent and are cheaper, if in rock formation, than pipe lines would be.

W. W. BRUSH, Chief Engineer of the Department of Water Supply, New York City, said that during 18 years of use the deep tunnels of New York City had not ceased to function for one minute. Mr. Brush thought, however, that all deep tunnels should be constructed in parallel to preclude possible disaster from failure of one or the other to continuously function.

THOMAS H. WIGGIN, Consulting Engineer, New York City, complimented Mr. Spear on his work with deep tunnel development. The early Croton supply tunnel, he said, crossed under the Harlem River at a depth of 300 ft. Depth of such tunnels was the all important feature. In limestone formation such tunnels would be unsatisfactory unless lined with steel, as had been resorted to in the New York projects with which he was familiar.

"Studies of Floc Formation by Means of Ferric Iron Coagulants"—by EDWARD BARTOW, A. P. BLACK, and W. E. SANSBURY.

The paper, presented by the senior author, disclosed the results from a study made of floc formation when using ferric coagulants. Such studies seemed timely in view of the increasing use of iron salts as coagulating agents. The value of ferric iron over ferrous iron seemed to be in the ability of the first to precipitate out at low as well as high pH values—the latter only at high pH values.

One difficulty had been encountered with ferric salts, as with alum, viz.: the existence of a pH zone in which flocculation was indifferent. The value of added sulphate ion in the form of sodium sulphate for improving flocculation had been previously demonstrated in connection with alum. Applied to ferric coagulation the effect in general was equally as good. Follow up work had indicated that calcium ions had greater value than sodium ions for aiding coagulation and the use of calcium chloride ($CaCl_2$) in dosages of between 40 and 80 parts per million had proven effective in speeding up flocculation and insuring complete precipitation at any point on the pH scale above pH 3.8. The use of the chloride had given results superior to any calcium salts tried. Sodium salts had proven far less effective when used in like concentration to the calcium salts.

The studies at the University of Iowa had led the authors to conclude that the changing of indifferent coagulation (in the zone between pH 6.5 and 8.5) to one of a satisfactory and rapid nature, which had resulted from the use of calcium chloride, was due to the change of some of the positively charged colloids to negatively charged ones. Such electronic change had resulted in attraction and agglomeration of the oppositely charged particles with rapid precipitation ensuing.

Generally speaking, the addition of sulphate ions (SO_4) had extended the zone of optimum floc formation into the acid zone more pronouncedly than into the alkaline zone. The chloride/ion has been more effective in extending the optimum zone to the alkaline side and consequently had been more effective in conjunction with ferric iron coagulation than had the sulphate. In either instance the addition of the bivalent calcium cation had been far more effective than had the monovalent sodium cation.

L. H. ENSLOW, in discussion, called attention to early work of Dr. Frank E. Hale, of the New York Department of Water Supply, in coagulation studies. Hale's interesting disclosures had been lost sight of probably because they were published before the era of pH in the Journal of Industrial and Engineering Chemistry of August, 1914.

Mr. Enslow reviewed the developments in ferric iron coagulation within recent years and especially the development and use of chlorinated copperas (ferrous sulphate oxidized by chlorine) as a coagulant which had been followed by the rapidly increasing use of ferric chloride. The latter had become even more attractive than copperas and chlorine at prevailing prices of chlorine, scrap iron and copperas because chlorine and scrap iron to produce 100 pounds of ferric chloride ($FeCl_3 : 6H_2O$) could be had now for 95 cents, equivalent to $1.68 per 100 pounds of $FeCl_3$ without water.

In reference to the relationship between time of floc appearance and completeness of iron precipitation as indicated in curves plotted from the Iowa studies the same curve applied in practice and it might have been drawn from plant operating data at Elizabeth City, N. C., or Providence, R. I., where soft waters were being coagulated with ferric iron. In each instance the precipitation was most perfect in the more acid range—never above 6.0 at Elizabeth City. At Providence a jump across the middle ground, to pH above 9.0, was practiced and both had been effective as was the case in the Iowa experiments.

The striking advantages gained through the applications of calcium chloride ($CaCl_2$) as revealed in the Iowa studies demanded serious consideration as a material possessing great possibilities in chemical precipitation practices whether it be in conjunction with water, sewage or industrial wastes. Aside from its value as an eliminator or moderator of the effect of pH value on coagulation, and thereby serving a much felt need, it would probably result in worthwhile coagulant savings. In connection with water purification, those waters presenting difficulty in coagulation between pH 6.5 and 8.5 would in general be found to be deficient in calcium salts needed to produce calcium carbonate film protection on

pipe lines. The mere raising of pH value of waters to secure carbonate coatings would not, and had not, proven adequate if calcium salts were not present to an extent greater than 35 parts, expressed as carbonate of calcium. To add 25 to 50 parts of calcium chloride as a coagulant aid would render it possible to use soda ash as the pH corrective on the filtered water and in so doing the calcium added plus any naturally present would be converted to the carbonate and deposit the desirable carbonate film on the interior of the mains and stop corrosion, the reactions involved being $CaCl_2 + NaCO_3 = CaCO_3 + {}_2NaCl$. It seemed evident that the potentialities of calcium chloride in the water works and sewage treatment field appeared to warrant its prompt consideration as an effective and economy producing material.

Prepared discussions by W. D. HATFIELD of Decatur, Ill., and E. S. HOPKINS of Baltimore, Md., were not read in the discussors' absence.

W. R. COPELAND, Engineer of the Board of Water Purification, Hartford, Conn., in commenting on the probable value of calcium chloride as a coagulant aid, referred to its successful use already in conjunction with chemical precipitation of an industrial waste in Connecticut.

H. E. JORDAN, Filtration Engineer, Indianapolis Water Company, Indianapolis, Ind., concurred in the caution sounded by Mr. Enslow, that in making changes in chemical treatment of water one should feel his way along with care rather than make sudden drastic changes without caution.

"The Status of the Ward's Island Sewage Treatment Works"*—by RICHARD H. GOULD, Engineer in Charge of Sewage Disposal, Department of Sanitation, New York, N. Y.

As a forerunner to the inspection trip made to the Wards Island Sewage Works, Mr. Gould presented an illustrated talk describing the design of the plant and degree of its completion. The plant had been designed for a 180 m.g.d. entailing pumping on the island to lift the crude sewage to primary Dorr clarifiers providing one hour of sedimentation. Beyond the clarifiers, were sixteen aeration tanks of 5.5 hours detention and of the spiral flow diffused air type. The final settling tanks equipped with Link Belt sludge removal mechanisms were 32 in number, providing one sq. ft. of surface area for each 1,000 gals. per day of sewage flow, including the 25 per cent sludge return to 180 m.g.d. sewage flow.

Air was to be fed under 7¾ pounds pressure. Sludge will be barged to sea for dumping not nearer than 10 miles off shore.

Construction of the plant had started in June, 1931, and was expected to be placed in operation in 1936, at a cost of $24,000,000 as against an estimated cost of $30,000,000. The Turner Construction Co. had been awarded contract "B" for $3,900,000. Construction had almost been completed after 18 months, whereas 4 years had been allowed.

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Book Reviews

pH AND ITS PRACTICAL APPLICATION

By Frank S. LaMotte, William R. Kenny and Allen B. Reed. Publishers—Williams & Wilkins Co., 262 pages. Price $3.50.

Reviewed by Sheppard T. Powell

A great many technical books are published annually for which there is little justification. A published text which does not contain new and useful data has little excuse for existence. It is gratifying, therefore, to review a new book, such as the one under discussion, which is not subject to these objections. A number of books relating to the determination of hydrogen values have appeared in recent years. Most of them, however, have been concerned with the theoretical phases of the art and have given little or no consideration to the practical phases of application of hydrogen ion control in industrial processes. The widespread application of pH control in many industries requires, at least, an elementary knowledge of the subject. The book by Dr. LaMotte and his associates fulfills these requirements.

The text is divided into Part A and Part B. The first section covers forty-eight pages and treats of the theory and mechanism of hydrogen ion determinations in simplified language. The latter portion of the book relates to the actual application of hydrogen ion control in the sanitation field and in industries, constituting a practical dissertation of control procedure and the requirements in numerous diversified processes. This portion of the book is invaluable and, alone, justifies its place in any scientific library. The authors have illustrated the book throughout by the use of ingenious but standardized charts indicating the important pH zones in water and sewage treatment and in various industrial processes. These charts are novel and greatly simplify the presentation of the data.

THE SANITATION OF WATER SUPPLIES

By Murray P. Harwood, Ph.D. Publishers—Charles C. Thomas, 181 pages. Price $3.50.

Reviewed by Sheppard T. Powell

So many books have been written on this subject, in recent years, that it is difficult to present much new material. Under the existing conditions, there is little in this book to recommend to advanced students, interested in water purification. Persons with no previous knowledge of the subject should find the text, however, of general interest. The author has presented a fairly comprehensive summary of the history and development of water purification processes, and the resulting beneficial effects as a public health measure. The book is divided into ten chapters. The first six refer to historical data, water supply requirements and a discussion of "Water as a Vehicle of Disease." The remaining chapters are devoted to water purification processes. The text is well illustrated with half tones, charts and tables.

STANDARD METHODS FOR THE EXAMINATION OF WATER AND SEWAGE

Published by The American Public Health Association. Price $2.00.

The American Public Health Association announces a new edition of Standard Methods for the Examination of Water and Sewage prepared in coöperation with the American Water Works Association.

The previous edition of Standard Methods is dated 1925. In the new edition, the Seventh, many important additions and changes occur. As examples, the method for total hardness has been extensively revised; the determination of the biochemical oxygen demand has been rewritten; the use of brilliant green lactose peptone bile is permissible in conjunction with standard lactose broth for water purification plant control; twenty-three methods of analysis which are not yet recommended as standard procedures, but which may be of use, are presented in abstract and with references.

Standard Methods is sold only through the American Public Health Association, 450 7th Avenue, New York City.

*See front cover for recent picture of the Ward's Island plant.

ECONOMY OF ELEVATED STORAGE STRIKINGLY SHOWN

By DONALD H. MAXWELL*

THE operating records of the Glencoe, Ill., water works furnish a striking demonstration of economy procurable through the introduction of elevated storage. In this case the savings in pumping costs, resulting from use of an elevated tank, are sufficient to cover all annual costs incident to the project.

The Glencoe pumping arrangements and filtration plant were designed to operate in connection with an elevated tank which was omitted in the original construction but the pumps operated against direct main pressures for about 4 years. Early in 1932, a 500,000 gallon elevated tank was added and now, after six months of operation, records under the new conditions are available to show a saving of about 33 per cent in power consumption.

The Glencoe filter plant has two motor driven low lift pumps each of two million gallons rated capacity and three motor driven high lift pumps, of one, two and four million gallons rated capacity respectively. In addition there is gasoline engine driven standby equipment. The average daily pumpage is approximately one million gallons, the rates varying from a minimum of approximately 420,000 g.p.d to a maximum of 3,300,000 g.p.d. The maximum hourly rate of consumption is approximately 5,200,000 g.p.d. and the minimum hourly rate is about 300,000 g.p.d.

Pumping Conditions With and Without Elevated Tank on the System

Comparison of these consumption rates with the installed pump capacities makes it evident that the high lift pumping operating against direct main pressures, with pumps throttled a considerable part of the time, was necessarily inefficient. The low lift pumping was also inefficient, owing to the desirability of maintaining a full clearwell and thus a 500,000 gallons storage. To do this it was the practice to operate the filters more or less continuously with the low lift pumps throttled. At times these pumps had to be operated at 15% of rated capacity.

With the elevated tank in service the high lift pumps now operate intermittently at about their rated capacity and best efficiency. With present practice, maintaining the clearwell storage at not less than 75 per cent full, is accomplished by running one or two low lift pumps which operate at about rated capacity during approximately the same periods as the high lift pumps are in service. The meter charts (Fig. 2) show distribution of high lift pumpage rates during typical days before and after putting the elevated tank in service.

Improved Pressures

The pressures maintained in the business district when pumping against main pressures varied over an extreme range of 40 pounds per square inch. The variation was from approximately 28 pounds minimum to 70 pounds maximum. Under present conditions, with the tank in service, a very uniform pressure is maintained, having an extreme range not to exceed 20 pounds. From 35 pounds minimum to 55 pounds maximum is recorded at the business center. The changed pressure conditions are clearly shown in Fig. 3, revealing recording gage pressures before and after providing elevated storage. The pumping rates for the same days for which the pressures are shown are recorded on Fig. 2. Neither record requires further explanation.

Fig. 1—500,000 *Gallon Elevated Tank, Glencoe, Ill.*

Savings in Power Consumed

As now operated the pumps run at capacity from 4 to 24 hours a day depending on the season, whereas formerly they ran continuously during periods of light as well as heavy demands. Much of the time they were throttled thus producing a very considerable sacrifice in efficiency as becomes apparent by comparing the power consumption with and without elevated storage, as shown in Table I.

During 1931 (operating direct pressure) the power consumption averaged 1,835 K.W. hours per million gallons delivered to the mains. During the six months of operation with the elevated tank in service, the power consumption per million gallons pumped has averaged only 1,235 K.W. hours, almost exactly two-thirds of the former power use and much more uniform as shown by the tabulation.

*Of Alvord, Burdick & Howson, Consulting Engineers, Chicago.

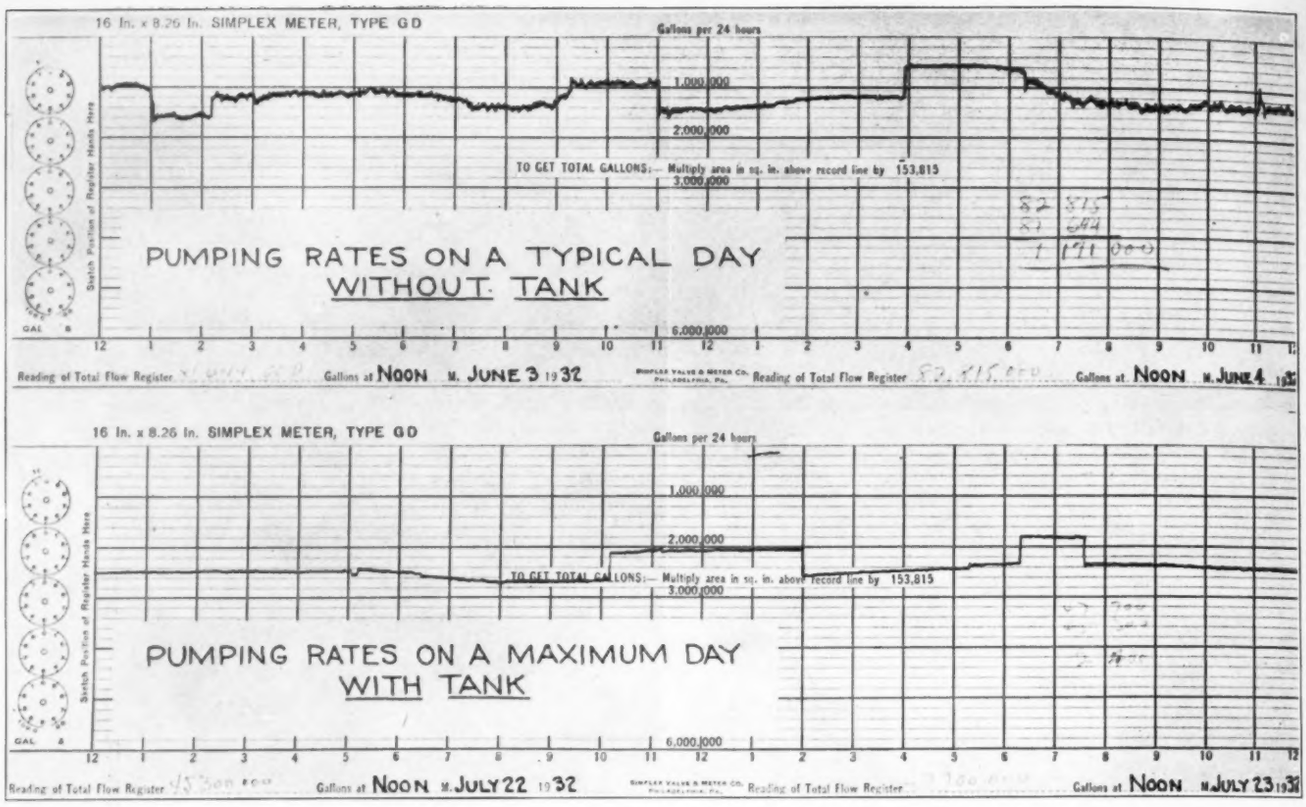
16 In. x 8.26 In. SIMPLEX METER, TYPE GD
Gallons per 24 hours
1,000,000
2,000,000
3,000,000
6,000,000
TO GET TOTAL GALLONS:— Multiply area in sq. in. above record line by 153,815
PUMPING RATES ON A TYPICAL DAY
WITHOUT TANK
Reading of Total Flow Register
Gallons at NOON M. JUNE 3 1932
Reading of Total Flow Register
Gallons at NOON M. JUNE 4
16 In. x 8.26 In. SIMPLEX METER, TYPE GD
Gallons per 24 hours
1,000,000
2,000,000
3,000,000
6,000,000
TO GET TOTAL GALLONS:— Multiply area in sq. in. above record line by 153,815
PUMPING RATES ON A MAXIMUM DAY
WITH TANK
Reading of Total Flow Register
Gallons at NOON M. JULY 22 1932
Reading of Total Flow Register
Gallons at NOON M. JULY 23

Fig. 2—Meter Charts Showing Distribution of High Lift Pumping Rates Without and With Elevated Storage

The saving in cost of power due to improved operation, made possible by the tank, cannot be properly shown by direct comparison of power bills for corresponding periods under the old and the new conditions because of the fact that a new power rate was introduced some time after the elevated tank went into service, and also because there has been a decrease in pumpage approximating ten per cent.

The fairest estimate of saving in power cost is obtained by applying the new power rate to the recorded 1931 pumpage as it actually occurred for comparison against the same monthly pumpage if delivered under more efficient operation as now attained with elevated storage. The saving calculated in this manner, amounting to approximately $2,500 a year, is sufficient to cover interest on the investment, depreciation (on sinking fund basis) and maintenance of the tank.

Thus, without added annual cost, the village has been able to avail itself of the many advantages of elevated storage which includes doubling of reserve storage,

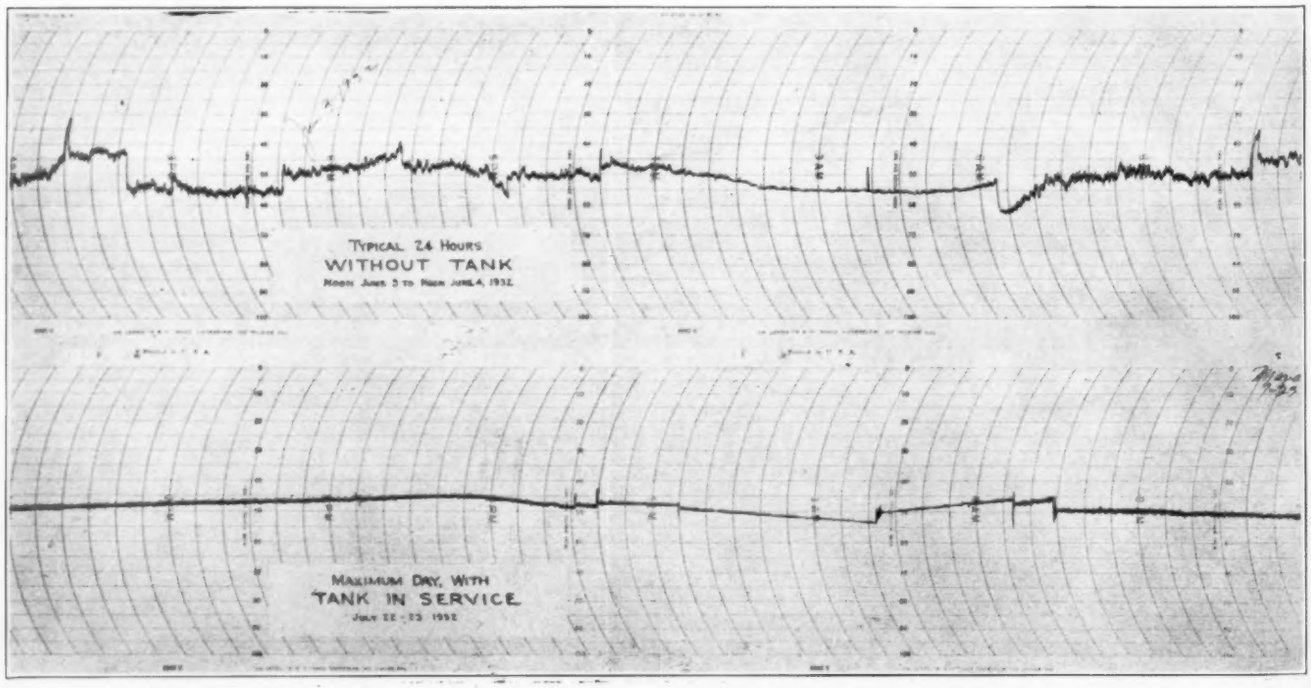

Fig. 3—Record Gage Pressures Before and After Elevated Storage in Service

TABLE I—PUMPAGE AND POWER DATA COMPARING OPERATION WITHOUT AND WITH ELEVATED TANK, GLENCOE, ILLINOIS WATER WORKS

Month	Pumpage, million gallons	Kw.hrs. per calendar month	Kw.hrs. per m.g.d.	Kw. max. demand
1931 (without tank)				
January	21.467	47,600	2,220	87
February	17.568	40,000	2,280	78
March	20.265	45,600	2,250	81
April	22.877	47,400	2,070	126
May	29.097	55,200	1,900	174
June	37.153	60,400	1,620	192
July	55.516	80,800	1,450	249
August	56.960	79,600	1,400	246
September	34.030	62,000	1,820	174
October	27.580	59,000	2,140	114
November	23.116	50,000	2,160	102
December	22.362	47,800	2,140	99
Total or average	367.991	675,400	1,835*	
1932 (only those months with new tank in service throughout month)				
March	21.578	27,400	1,270	117
July	45.083	55,200	1,225	186
August	46.437	56,800	1,225	189
September	38.920	47,200	1,210	168
October	23.700	29,600	1,250	174
November	19 502	25,000	1,280	120
Total or average	195.220	241,200	1,235*	

*Weighted average.

better fire protection uninterrupted and more uniform water pressure, greater flexibility of filter and pumping operations and increased plant reliability.

It is worth noting that the saving in cost of power would have been greater if Glencoe had happened to enjoy a uniform rate of power, such as applies in many plants. In reducing the power consumption by 33 per cent the plant is not able to earn proportionately as good a rate. The estimated net average power cost based on the new rate when applied as above explained to 1931 pumpage without the tank nets 1.27c per kw.h. whereas with the tank it is increased to 1.36c per kw.h.

Auxiliary Equipment

The elevated tank is equipped with an altitude valve and a remote indicating water level gage is installed in the pumping station 2⅓ miles away to make practicable the full use of the storage capacity available.

The elevated tank was supplied by the Chicago Bridge & Iron Works. The Glencoe plant is in charge of E. L. Pflanz, Superintendent, under George R. Young, Village Manager.

A Sewage Disposal Problem of Interest—And a Case at Law

An interesting court action has recently been held in the city of Toronto in which the plaintiff, Miss Hunter, claimed $10,000 damages against the Union Sewerage Commission of Mimico and New Toronto. The plaintiff's action was to the effect that her property had been damaged as a result of odors arising from the lake shore in the vicinity of the outfall pipe from the defendant's sewage treatment works.

The action originated in 1931, and was based primarily on odors which were extremely offensive during that summer. Complaints were also made that the operation of the plant and maintenance of the outfall sewer through the plaintiff's property was such that she was greatly inconvenienced and suffered a depreciation in property value. The chief cause of complaint, however, was due to the decomposition of a deposit which occurred along the water front in that vicinity. The local situation was as follows at the time of the action:

The towns of Mimico and New Toronto jointly operate a sewage disposal plant. The flow of sewage is between 2½ and 3 million gallons per day. The plant, at the time the action was launched, consisted of an Imhoff tank and sprinkling filters. The system had been constructed a number of years previously and as the population increased the flow of sewage was considerably beyond the designed capacity. All of the sewage passes through the Imhoff tank and part of it through the sprinkling filters containing brushwood as the medium. From the plant the effluent passes through a long outlet sewer through the Hunter property and thence to an outfall extending about 700 ft. from the shore. The water at the outlet had a depth of approximately 10 ft. In 1926 the outfall pipe was extended from the shore line to this point in the lake. At that time an agreement was made with the Hunter estate whereby a sum was paid for right-of-way to take care of any damages which might have prevailed before that date. The action was thus based entirely upon conditions subsequent to 1926.

The plaintiff claimed in her action that the sewage was very improperly treated and that when it discharged into the lake the solids, carried out in the effluent, were deposited on the lake bottom and eventually carried back to shore to form the objectionable deposits which were known to have given off very offensive odors. Complaints were made of conditions in practically every year following 1926. The worst season was said to be 1931.

The defense claimed that the deposits were due to an algal growth, namely, cladophora and that this material, growing in profusion along the water front, was broken off from the stones by wave action, and was carried into the shore where, in the shallow water, it decomposed and gave off the offensive odors. To substantiate this claim it was pointed out that similar conditions had been met elsewhere and in addition this material accumulated on the shore only in the warm weather of the summer. Further it was pointed out that the growth took place only where there was a rocky or stoney bottom and not where the beach was sandy. The area on which the deposit formed was quite stoney and the water shallow. The summer of 1931 was particularly warm and this growth developed much earlier than in previous years. By the middle of June the deposit had become offensive and decomposition had set in to such a point that extremely bad odors were given off. During the summer of 1932 a similar condition prevailed but at a later date.

In answer to this defense the plaintiff attempted to show that algae and sludge were mixed together and that sludge being carried in towards the shore had killed the algal growths. The mixture had then been washed into shore where by the action of the sludge, decomposition had set in.

The case was a highly technical one and took eight days to complete. Judgment was reserved and as yet no decision has been made. The case is interesting in that conditions are similar to those experienced in a number of other places where sewage treatment has been in operation, and even where no sewage effluent has been discharged. It also raises the question as to what effect the discharge of a treated effluent will have upon algal growths. Should sewage treatment be such that it will not favor these growths—or is the usual oxidation form of treatment to prevail and some other measure taken to prevent the occurrence of this condition? A nice question.

LOSS OF HEAD AND BACKWASHING VELOCITIES FOR ANTHRACITE COAL IN WATER FILTERS

By HOMER G. TURNER[1] and G. S. SCOTT[2]

ANTHRACITE has been shown to consist largely of carbon[3] rather than hydro-carbons, and to possess some absorptive properties[4] even in its native state. It has a range from 1.49 to 1.68 in specific gravity, giving a bulk weight of 52 to 58 pounds for crushed material. The particles are angular in shape and free from pitted surfaces. Its behavior in the filter bed is essentially what one would expect from its physical and chemical properties. The physical properties alone will be considered in this paper which will be restricted to the results of measurements of loss of head and backwashing velocities. The initial loss of head in filtration through anthracite is dependent upon effective size, degree of uniformity, shape of particle, water temperature, depth of bed, and rate of flow, just as for any other filter material. The backwashing velocities required are materially lower than for other filter media because of the low specific gravity. Anthracite has a specific gravity ranging between 1.49 and 1.68, when determined in water after boiling out the air and absorbed gases.

Table I contains the physical data for the various anthracites and sands used in the investigation. The last column, marked "Curve No." refers to the corresponding curve on Fig. 2 for backwashing velocities.

TABLE I.—PHYSICAL DATA FOR ANTHRACITES AND SANDS.

Material	Size*	Effective Size	Uniformity Coefficient	Specific Gravity†	Curve No.
Anthracite	0 × 10 m	0.38	2.89	1.66	1
Anthracite	30 × 40 m	0.44	1.19	1.40	2
Anthracite	20 × 40 m	0.46	1.45	1.51	3
Delta Sand	40 × 60 m	0.27	1.32	2.67	4
Anthracite	20 × 30 m	0.61	1.21	1.41	5
Delta Sand	30 × 40 m	0.44	1.19	2.67	6
Anthracite	10 × 20 m	0.96	1.61	1.55	7
Delta Sand	20 × 30 m	0.61	1.21	2.67	8
Ottawa Sand	20 × 30 m	0.61	1.21	2.65	9
Anthracite	8 × 10 m	2.04	1.09	1.53	10
Anthracite	4 × 8 m	2.62	1.45	1.58	11

*U. S. Standard Sieves.
†Determined in water without boiling, to duplicate apparent specific gravities under filter bed conditions.

Initial Loss of Head

While this work was being done at Pennsylvania State College, a very accurate and thorough piece of work on the initial loss of head through various sands was conducted at Detroit by Hulbert and Feben.[5]

Their work is the only published work of its kind so far as the writers know, and is of considerable theoretical interest. It is not within the scope of this paper to summarize their results here, other than to state that the initial loss of head can be computed to within about 5 per cent from an accurate sizing test of the material to be used in conjunction with a porosity determination. For the details of procedure and methods of computation, the reader is referred to the original paper.

In the work in the Anthracite Institute Research Laboratory, the aim was to determine the actual losses of head through beds of anthracite of different sizes and degrees of uniformity, and to express the results in the form of an equation so that any waterworks engineer could, with minimum effort, determine and specify the proper size and uniformity of anthracite for any given initial loss of head.

The results obtained are in excellent agreement with those of Hulbert and Feben,[5] although the equation could not be carried to the same high degree of refinement and still retain its simplicity.

The experimental apparatus consisted essentially of a vertically fixed Pyrex glass tube, 36 in. long, 1½ in. in diameter, with a rubber stopper in the bottom. A ⅜ in. glass tube passed through the rubber stopper. Supporting the bed of coal was a small iron wire screen. Water from the tap was run into the tube at the top. The water temperature was read from a thermometer suspended above the bed. A constant head was maintained by means of a U-tube inverted with one leg dipping down into Pyrex tube and the other leg connected to the suction line. To estimate the effect of the Pyrex tube wall, tubes of diameters from 1 in. to 2 and 5/16 in. were used. The resistance of the wire screen, end contraction, and outlet tube was determined by separate test for different flow rates, and a corresponding correction was made in the loss of head. This correction was practically negligible for sizes of anthracite applicable to slow and rapid filters.

The anthracite, or sand, was poured into the Pyrex tube dry, or in a so-called "random condition." After the water had reached a constant temperature, it was turned into the tube, the suction turned on, and as soon as the head became constant, that is, had reached the suction tube, the rate was determined by catching the effluent in a graduated vessel during a short period of time, measured with a stopwatch. The results of these tests inserted in the formula

$$\text{Rate} = \text{Ke}^2 \frac{\text{h}}{\text{L}} \left(\frac{\text{t} + 10}{60} \right)$$

(derived from Poiseuille's law), gave values of K varying with the effective size, and the uniformity coefficient. When the reciprocal of the effective size was plotted against k/c, (c being the uniformity coefficient), a straight line passing through the origin was obtained. Solving this straight line equation for k, and substituting the value so obtained in the above equation, we obtain, for anthracite,

$$\text{Rate} = 263 \frac{\text{ceh}}{\text{L}} \left(\frac{\text{t} + 10}{60} \right)$$

where Rate is expressed in gallons per square foot per hour.
c is the uniformity coefficient.

[1]Director of research for the Anthracite Institute.
[2]Assistant Director, School of Mineral Industries, The Pennsylvania State College, State College, Pa.
[3]Turner and Anderson, "A Microscopic and X-Ray Study of Pennsylvania Anthracite," Industrial and Engineering Chemistry, Vol. 23, Page 811, July, 1931.
[4]Sinkinson and Turner, "Absorption of Carbon Dioxide by Coal," Industrial and Engineering Chemistry, Vol. 18, Page 602, June, 1926.
[5]Hulbert and Feben: "Hydraulics of Rapid Filter Sand," J. A. W. W. A., 1932.

e is the effective (10 per cent) size in millimeters.
h is the loss of head in inches of water.
L is the depth of filter bed in inches.
t is the Fahrenheit temperature.

The published data for flow of water through sand gives values of k ranging from about 400 to 1,200. The relation observed here, that k is a function of effective size and uniformity coefficient, permits a more accurate preliminary estimate of flow rates to be made. It must not be forgotten, however, that this substitution for k is

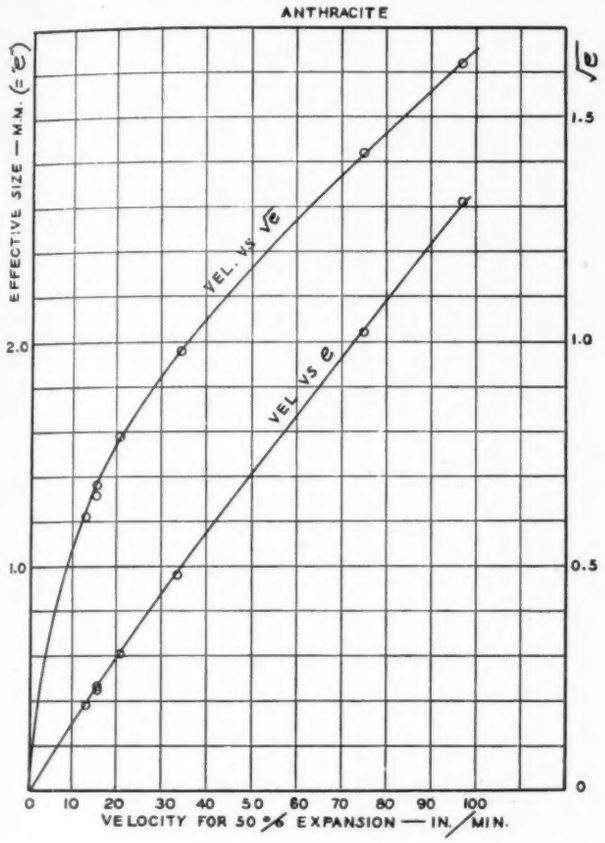

Fig. 1. Upward Wash Water Velocities (Inches of Rise Per Minute) Required to Effect a 50 Per Cent Filter Bed Expansion When Using Anthracite Coal of Various Effective Sizes.

purely empirical, and is useful over the working range only, that is, for sizes between about 4 and 60 mesh, and with uniformity coefficients up to about 1.6 (higher uniformity coefficients tend to invert the calculated data). Within the limits given, the results calculated from the above modified formula agree with the experimental results to within 10 per cent.

Tests were also made on the same beds after "classification," a condition that would obtain immediately after backwashing a filter. The effect of backwashing, or classifying the bed was to materially decrease the loss of head, by removing the finer sizes from the interior of the bed and placing them on top of the bed, thus increasing the void spaces, and somewhat increasing the depth of material.

Considerable difficulty was experienced from air binding which appeared shortly after putting a fresh bed of either anthracite or sand in service. When distilled water, or water that had stood for some time, was used the air worked out of the bed after a time and no further evidence of air binding was noted. When fresh tap water was used the air binding continued, more or less indefinitely, changing in degree from day to day. It was noticeably greater after a rain.

The results on air bound beds are given here as qualitative information only, because they would no doubt be different from those obtained under other conditions.

The numerical factor in the above equation for rate of flow or loss of head is tabulated below for different conditions.

TABLE II.—NUMERICAL FACTOR IN FLOW EQUATION.

Material	Random Bed	Classified Bed	Air Bound Bed
Anthracite	263	520	120
Delta Sand	236	440	100
Ottawa Sand	280	470	120

In connection with these results, it should be remembered that the anthracites are angular in shape whereas delta sand (a commercial filter sand) is of irregular shape with rounded points and Ottawa sand is a well rounded sand.

Backwashing Velocities and Filter Bed Expansion

The principles involved in washing coal or sand in a rapid filter are essentially those of suspension of solid particles in an upward current of water. A number of formulae are given in various books on ore dressing and coal preparation, which depend to a great extent upon the detail of conditions surrounding the specific case under consideration. One of the very simplest of these formulae is that of Rittinger for free settling. By changing the exponent of the particle diameter from ½ to 1, since the sizes of particles are in the intermediate

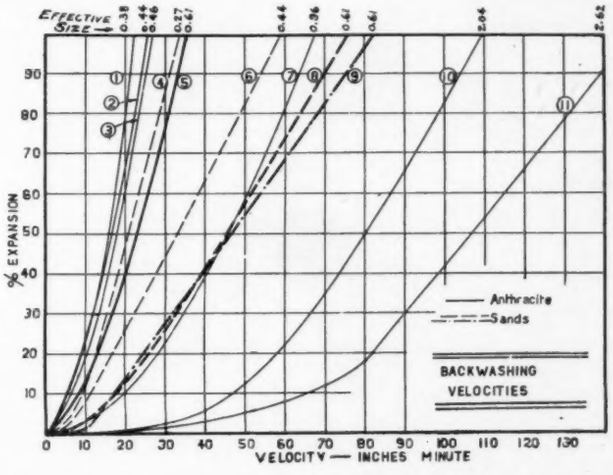

Fig. 2. Expansion of Filter Beds of Various Materials Secured With Various Rates of Wash Water Application Expressed as Inches of Rise Per Minute. (Effective Sizes of Each Are Indicated at the Top.)

range, the Rittinger formulae can be used to calculate the velocity required to cause a 50 per cent expansion of the bed on backwashing.[6]

Figure 1 shows the velocities required for 50 per cent expansion of the bed plotted against effective size and also against the square root of the effective size. The velocities are corrected to a temperature of 50 degrees F., and to a particle specific gravity of 1.60. Examination of this graph shows conclusively that the square root of the particle size, as shown in the Rittinger formula does not hold here, and also that for an exponent of one, the curve is so near a straight line that for the range of sizes used in rapid filters, e to the first power may be used with no appreciable error.

[6]A 50 per cent expansion of the filter bed is given as the optimum expansion by Hulbert and Herring, in "Studies on the Washing of Rapid Filters," Journal of the American Waterworks Association, Vol. 21, Pages 1445 et. seq., 1929.

For both anthracite and the delta sand, the formula becomes

$$V = 45.7\ e \left(\frac{t + 10}{60}\right)\sqrt{d - 1}$$

where V is the velocity in inches rise of water per minute.
e is the effective diameter of particles in millimeters.
t is the Fahrenheit temperature.
d is the specific gravity of particles.

For the rounded grains of Ottawa sand, the numerical factor becomes 56.2 instead of 45.7, the other items remaining the same.

Figure 2 shows the relation between backwash velocity, determined by experiment, and the per cent expansion of the filter bed for the various materials tested. A comparison of curve (5) with curves (8) and (9) shows that with anthracite and sand of the same size, the backwashing velocity for anthracite to secure 50 per cent expansion is 50 per cent less than for sand. This should be a distinct advantage in many plants which are so designed as to be unable to secure a 50 per cent expansion of a bed of sand. The experimental apparatus was essentially the same as that used by Hulbert and Herring, referred to above. Another point of interest is that a straight line is obtained for the rounded Ottawa sand while a slight curvative is shown for the materials of irregular shape.

Acknowledgment—

The writers take pleasure in acknowledging the kindness of Professor George Fancher and Mr. James Lewis of the Petroleum Research Division for critically examining the data here presented. Acknowledgement is also made to the Mineral Industries Experiment Station of the Pennsylvania State College for coöperation in this work.

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SLUDGE BLANKET DETECTORS

By WELLINGTON DONALDSON*

THE article by S. Vermilye in the January issue of WATER WORKS AND SEWERAGE† gives an excellent description of the sludge level finder used at Tenafly, N. J., and particularly emphasizes its practical utility in the operation of an activated sludge plant. The device described, which Mr. Vermilye found at the Tenafly plant when he took charge, was constructed by his predecessors, C. L. Fuller and A. Lawrie Kurtz, and was put into service in the summer of 1931. A similar device was used at the Hagerstown, Md., plant in the fall of 1931, prior to a reconstruction program.

The Tenafly plant was originally furnished with the Milwaukee type of sludge finder, consisting of a series of small wide-mouthed bottles clamped to a rod at 1 ft. intervals, with arrangements for pulling out corks in rapid succession from top to bottom by a single cord. Probably the bottle device had its origin at the Milwaukee testing station, but it was used at the Indianapolis testing station in 1921 and has been in common use at a number of activated sludge plants since. The bottle device is generally considered an unwieldy instrument to handle. The bottles are a nuisance to keep clean and the indications of sludge level are anything but precise.

It is probably impossible to trace the origin of the idea of using a pipe or tube fitted at one end with a glass window, and having a light in front with a gap between light and window sufficiently small that the light will be obscured in the sludge blanket but not in the supernatant. A sight device was used in Indianapolis in 1925 or 1926 for observing not only the sludge blanket but the movement of particles in the secondary clarifier. The device, consisting of a 4-in. tube with a 500-watt lamp, although useful for special exploration and study of clarifier behavior, was too cumbersome for routine use and was supplanted in 1932 by a device using a battery light similar in some respects to the one described by Mr. Vermilye.

Those who visited the Mamaroneck, N. Y., activated sludge plant in 1927 probably noted a sludge finder installed there by William Bloecher, Chief Engineer of the then Sanitation Corporation. It consisted of a pipe containing a selenium cell and fitted on one end with a glass window and light. The pipe was supported on a pedestal by trunions so that the light could be lowered in the manner of the classic "old oaken bucket" to any desired depth in the clarifier. The installation was an experimental one apparently for the purpose of developing an automatic device for operating sludge pumps or otherwise keeping the sludge blanket at some predetermined level. It was not used in routine operation of the plant and is reported to have been shipped to the Chicago Sanitary District for experimental use there.

With the inexpensive and sensitive photo-electric cells and relays now available on the market, it is a very simple matter for the plant operator to make up a reliable sludge blanket finder without the inconvenient feature of the Tenafly device which requires the observer's eye to be shifted as the tube is lowered or raised in the clarifier. Such an arrangement has been planned for Hagerstown, utilizing a light or gong as the signal of sludge blanket level. Of course if one is interested in actually observing the sludge blanket, then a large tube or a glass bottomed boat is the thing to use.

It may be remarked in passing that when using flashlight lamps and batteries a single wire conductor to the lamp suffices, the pipe constituting the return circuit. With high voltage lamps operating from the lighting circuit, it is, of course, necessary to provide waterproof housing for the lamp and connection.

A great many sewage plants have home-made "gadgets" of various kinds for simplifying and improving plant control. It is hoped that others will follow Mr. Vermilye's example of publishing a description of some of these handy devices so that other operators may benefit.

▼

West Shore Water Producers' Association Installs New Officers

At the meeting of the West Shore Water Producers Association, held Jan. 25th at Racine, Wis., the following officers were installed:

Chairman, E. L. Pflanz, Supt., Water Works, Glencoe, Ill.; Vice-Chairman, James Ashworth, Supt., Filtration, Waukegan, Ill.; Recording Secretary, Carl Leipold, Supt., Filtration, Winnetka, Ill.

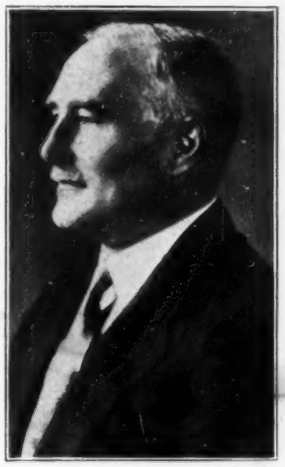
Papers read at this meeting included: "Relation Between Water Rates and Construction Policies in Municipally Owned Plants," by L. R. Howson of Chicago. "The Economic Replacement of Pumping Equipment," by H. P. Binder of Milwaukee, Wis. "Chlorophenol Tastes and Odors," by Arthur E. Gorman of Chicago.

*With Fuller and McClintock, Engineers, New York City.
†"Activated Sludge Blanket Depth Detector"—WATER WORKS AND SEWERAGE, January, 1933—p. 34.

CHLORINE ABSORPTION BY SEWAGE SLUDGE*

By WILLEM RUDOLFS

Chief, Department Sewage Research



Doctor Rudolfs

IN chlorinating sewage it is known that a portion of the chlorine combines with materials in solution and another portion with the solids. It was thought of interest to determine how much chlorine would be absorbed by sludge and what proportion would be accounted for in the liquid as chlorides. Two hundred c.c. portions of fresh solids were placed in Hempel pipettes connected with gas holders. Definite quantities of chlorine were introduced into the gas container and the chlorine gas left in contact with the unstirred sludge for certain lengths of time. The amounts of gas absorbed, expressed in p.p.m. and the increased content of chloride chlorine found in the liquid is graphically shown in Fig. 1. Gas absorption was very rapid during the first half hour, decreasing during the next 6 hours and was very slow for the remainder of the 24 hours. The increase in chlorides in the liquid was rapid during the first half hour, slow for the next 3.5 hours and more rapid during the following 12 hours, after which there was practically no further increase.

Gas penetration, or absorption was not uniform, probably due to the fact that the sludge was left quiescent, but penetration must have been fairly complete as evidenced by the reduction in total bacteria. Some of the data obtained are summarized in Table I, where the total numbers of bacteria remaining in the sludge are also shown. The rapid reduction of bacteria during the first half hour would indicate that those present in the liquid were readily killed. This effect was coincident with the rapid absorption and considerable increase in chlorides in the liquid, which increased during the first half hour as much as was the case during the next 7½ hours. It may be assumed, therefore, that those substances in the liquid (soluble and colloidal) capable of combining with the chlorine gas were taking up a large portion of the chlorine during the first half hour. Of interest is the slowing up of chloride formation in the liquid which was coincidental with a slowing up of the bacterial death rate, particularly noticeable during the 2½ hours following the first half hour of rapid absorption.

*Journal Series paper, N. J. Agricultural Experiment Station, New Brunswick, N. J., Department of Sewage Research.

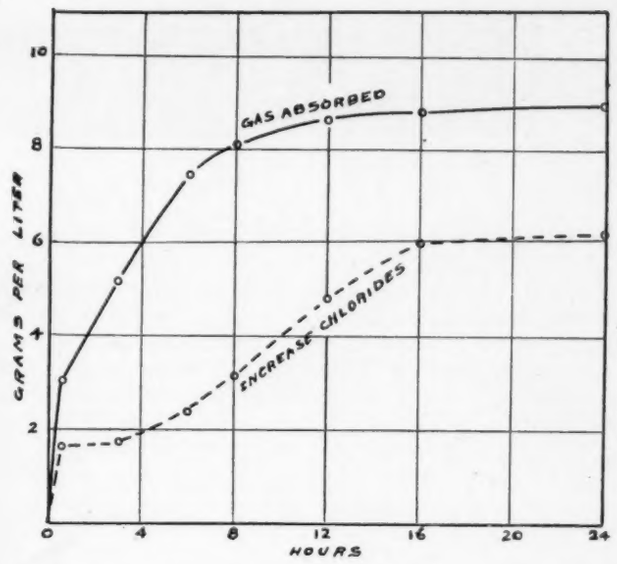


Fig. 1. Relation Between Chlorine Gas Absorbed and Increase in Chlorides in the Sludge Liquid.

After the substances in the liquid capable of combining with chlorine were more or less saturated apparently gas absorption by the organic solids continued to take place. The difference in chlorine formation and gas absorption would seem to indicate that the organic solids absorbed the gas simultaneously with the material in the liquid, and that the rate of absorption was greatest during the first 6 hours. The rate of absorption declined during the next 10 hours and was constant during the last 8 hours when comparatively little gas was absorbed in spite of the fact that all solids had not been penetrated sufficiently to kill the remaining 2 per cent of the bacteria. It would appear, therefore, that considerable time is necessary before the chlorine penetrates the coarsest sludge particles left undisturbed in contact with the gas. On the other hand, when no coarse particles are present penetration and combination of the gas is rapid, resulting in a speedy destruction of the organisms present.

If the absorption and penetration of the chlorine are considered as oxidation processes, the explanation of the results observed is simple. Those substances in solution capable of oxidation are first oxidized, followed by an attack on materials in finely divided state (colloidal, bacteria, etc.) and finally the more resistant substances (organic matter in suspension) are attacked by the chlorine. If such a procedure takes place there should be complete oxidation of some of the putrescible materials, which are amenable to decomposition or stabilization, with a resulting absolute reduction in the biochemical oxygen demand of the material. Results obtained in this laboratory and elsewhere seem to confirm this explanation of the power of chlorine to convert putrescible to non-putrescible products and the consequent reduction of oxygen demand values.

TABLE I.—PART OF CHEMICAL AND BACTERIOLOGICAL RESULTS.

Time	Liquid	pH	Acidity	Alkal.	Gas absorbed		Increase chlorides	Total bacteria*
hrs.			(ppm.)	(ppm.)	(cc.)	(ppm.)	(ppm.)	
0	Blackish	7.1	2.4	2,060	0	0	.....	200
¼	Slightly clearer	7.1	2.4	2,014	19.4	3,010	1,600	80
3	Clearer	7.0	8.4	1,996	32.4	5,140	1,770	40
6	Much clearer	6.9	4.9	2,014	47.5	7,520	2,420	4.3**
24	Opaque	6.9	3.5	1,920	56.9	9,020	6,230	4.0

*Millions per c.c.—agar plate counts.
**Represents a reduction of 97.85%.

EDITORIALS

Chemical-Mechanical Treatment

IN viewing the recent literature, including the pages of this publication, one must be impressed with the fact that chemical treatment and mechanical equipment occupy a high position in the interests of professional men dealing with water purification and sewage treatment problems.

In the water treatment field results attained with the mechanical *flocculator,* conceived and developed at Richmond, Va., have again brought forcefully to the attention of operating and designing men, the value of mechanically conditioning the chemically treated water. The adaptability of the flocculator to use in existing basins adds attractiveness to this ingenious contrivance and, like many other developments of value, the application of the principle is so simple an expedient that it seems strange it was not thought out and perfected years ago.

In connection with sewage treatment, a very similar mechanical paddle wheel device has been placed in operation at several of the recently built sewage treatment works employing the activated sludge process. It serves the dual function of keeping the sludge flocs moving and accelerates their agglomeration in the aeration tanks, and produces a more complete utilization of the air forced into the sewage. Its chief demand for attention is found in the fact that it reduces the cost of treatment. In water coagulating the flocculator reduces coagulant consumption, and thereby treatment costs. On the same score, and perhaps to even a greater extent, it bids fair to prove its value in chemical treatment of domestic and industrial sewages.

In the disposal of sewage sludge, mechanical handling offers the most clean cut and simple means of solving the sludge question. More to the point—it now seems probable that the use of conditioning chemicals and vacuum filtration will prove to be likewise the least expensive of the methods of dewatering sewage sludges at the larger plants. Rapid drying and incineration of the moist cake from the filters (now under development) is the next step toward the production of a nuisanceless process of complete disposal—probably on practically a self-supporting basis. Incineration of screenings from coarse and fine (mechanical) screens is an established practice at the Westchester County, N. Y., plants and elsewhere. That Los Angeles, Calif., has just let contracts, for what will be the largest screenings incinerator in the world, is indicative that results from incineration have been convincing and that this method of disposal is becoming an established practice.

One hears much now concerning chemical precipitation of sewages. This idea is not new but, nevertheless, the improved chemical precipitation processes must be considered as new in the same sense that one uses old things as patterns in developing improved and therefore new things. In combination with mechanical flocculating devices, modern sludge handling and disposal equipment, mechanical filtration of effluents and chlorination, the new developments resemble but slightly the old "patterns" of the '90s.

The use of chlorine, applied to sewers to maintain sewage in fresher condition and thereby relieve odor nuisance and to render the sewage more submissive to satisfactory purification at the treatment works, is relatively new. The efficacy of the treatment, as exemplified by results procured in the Los Angeles County Sanitation Districts, is worthy of increasing attention. In rendering a biological plant capable of handling greater volumes of sewage, chlorination becomes both scientifically and economically interesting. That chlorination of effluents produces real and dependable reductions of their oxygen requirements, resulting in actual stream improvement, has been sufficiently demonstrated, notably at Chapel Hill, North Carolina. This, plus its added ability to clear up unsightly biological growths from receiving waterways, gives new values to the practice of sewage chlorination. Particularly is this true where unfavorable seasonal conditions must be met and where, as at present, funds for meeting such are limited.

Although chemical treatment of sewage was once a closed chapter in sewage treatment practice—and tightly closed for a number of years—there now seems to be a greater appreciation of values and the need for a process less sensitive than the activated sludge process; less space requiring and nuisance producing than sprinkling filters —and less costly than either. Some form of chemical precipitation in conjunction with mechanical filtration (and chlorination where needed) bids fair to become an established practice for filling a demand, created by the gap now existing between the results procurable from plain sedimentation practice and those which necessitate biological secondary treatments. The visible appearance of the chemically produced effluent is in its favor as is its freedom from sludge producing matter. To meet permanent success, the cost of the chemical process —like the results procured—must fit into the gap between the cost of plain sedimentation and that of the biological processes. With the proper methods of attack—utilizing the most improved technic—the last requirement stands more than a fair chance of being met.

In January a paper was presented before the Sanitary Division of the A. S. C. E. by Dr. Bartow of Iowa and Professor Black of Florida which disclosed some of the controlling elements securing effective precipitation with ferric iron coagulants. Startling results, reported elsewhere in this issue, were procured in the way of improving flocculation by the simple expedient of adding to the water a small quantity of such a commonplace chemical as calcium choride. Experiments undertaken by others have already shown that the same effects can be procured from the use of moderate dosages of this same chemical in the coagulation of sewage with ferric chloride. Furthermore, it has been shown that the quantity of coagulant might be reduced and an overall economy realized in consequence.

If thorough study and sound development work be applied in perfecting methods, chemical precipitation of sewages and industrial wastes should develop into a highly useful and economical process. The road of the pioneer is not, however, an easy one in this field and unless he be hardy he should not attempt to travel it.

NEW EQUIPMENT AND MATERIALS

New Bailey Sewage Meters

A complete line of Bailey meters for sewage treatment plants and water works has been announced by the Bailey Meter Company, Cleveland, O.

The accompanying picture illustrates the float operated register for accurately measuring the flow of sewage, sludge, dirty water or other liquids using a Venturi tube, flow nozzle or orifice as the primary element. The instruments indicate, integrate and record flow; charts being 12 in. in diameter with uniform graduations.

Bailey Meter

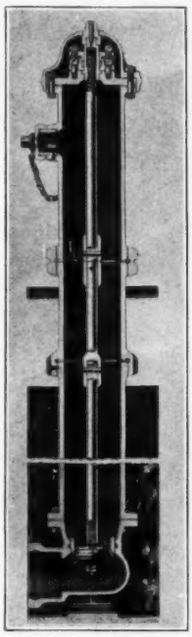
Because this meter has been designed specifically for the services mentioned, it incorporates many features which are particularly desirable. For example, the maximum capacity can be easily changed by changing two sets of gears in the register mechanism. This feature eliminates excessive costs for the replacement of Venturi tubes since exceptionally wide variations in capacity can be obtained without removing the primary element from the line or disconnecting the meter in any way. All parts are made simple, positive acting and sturdy, so that continuous trouble-free operation is assured. The standard dust and moisture-proof pressed steel register casing, in which the recorder and integrator are contained, is designed for either flush front or surface mounting. The instruments are ordinarily supplied mounted flush or an individual panel as shown in the illustration, although they may be supplied unmounted for grouping in a meter gallery or for installation on an existing panel board. Any number of instruments can be operated at remote points from the main register if desired.

In addition to the meter just described, a variety of other types are available to meet the particular requirements of the installation and for various services throughout the sewage treatment plant and water works. All of the meters, however, harmonize in appearance so that a neat installation may result when they are grouped.

Bulletin No. 39—"Bailey Meters for Sewage Treatment and Water Works," profusely illustrated, has just been issued for free distribution by the Bailey Meter Company, Cleveland, O.

Kennedy Fire Hydrant Extension Section

The Kennedy Valve Manufacturing Company announces that it has developed an extension section, by means of which the Kennedy Safetop fire hydrant can be lengthened for raise in street grade by one man, within 30 minutes, without excavating, and without shutting off the water service.



Fire Hydrant Extension Section

The Kennedy safetop fire hydrant permits this speedy, convenient and low-cost adjustment because of the two-part construction of the hydrant standpipe and stem, with ends abutting at the patented safety breakable section of the hydrant which is located a few inches above the ground line. This breakable section, which protects the major and expensive parts of the hydrant from injury in case of a smashing impact from a colliding vehicle, consists of a standpipe breaking ring, which is screwed to the upper and lower standpipe sections, and a stem coupling.

If the grade of a street on which a Kennedy Safetop hydrant is located is to be raised, the breaking ring and stem coupling are simply disconnected from the upper and lower standpipe sections respectively, a standpipe and stem extensions of suitable length connected on top of the section of the hydrant in the ground, and the upper standpipe and upper stem sections connected on top of the standpipe and stem extensions.

Both ends of the standpipe extension are threaded so that the breaking ring can be screwed on to the upper male thread end and the lower female thread end screwed over the lower standpipe section in the ground into a lock screw for permanent connection to the lower standpipe section. Both ends of the stem extension are drilled so that the upper end can be pinned to the stem coupling and the lower female end pinned to the lower stem section.

The entire assembly is perfectly rigid and fully as strong as any one-piece hydrant of the same diameter of standpipe. Further details of this feature and a complete description of the Kennedy Safetop fire hydrant can be obtained by addressing the Kennedy Valve Mfg. Co., Elmira, N. Y.

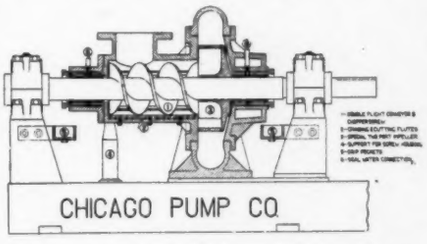
A Screw-Feed Centrifugal Pump Designed for Handling Sludge

The Chicago Pump Company has recently developed an entirely new idea for the pumping of heavy sludge in sewage disposal plants or high consistency liquids in industrial processes.

The diagram shown on this page indicates the principle of this new pumping unit. Sludge or other heavy materials are conveyed to the pump by a conveyor and cutting screw. This screw is of the double-flight type and each passage in the screw connects with its own port in the impeller. In the screw housing are four hardened flutes. These flutes assist in guiding the sludge to the impeller, and provide a cutting edge for the solids. Thus, the Screw-Feed design directs all articles through the pump on a continuous stream-line. It also breaks and cuts up anything that would otherwise be impossible to handle.

Some of the things which have been handled successfully by the Screw-Feed Centrifugal Pump are papers, leaves, rags, sticks, rubbers, carcasses, bones, golf balls, rope, wire, fruit and fruit seeds and vegetables. It will be readily recognized that the pumping of liquid containing these materials is not a very simple problem. The unusual design in this pumping equipment insures the handling of primary sludge with a minimum amount of trouble. The principle has never before been used in sludge pumping.

The Chicago Pump Company has issued



The Screw-Feed Centrifugal Primary Sludge Pump, Developed by the Chicago Pump Co. (Patents Applied for)

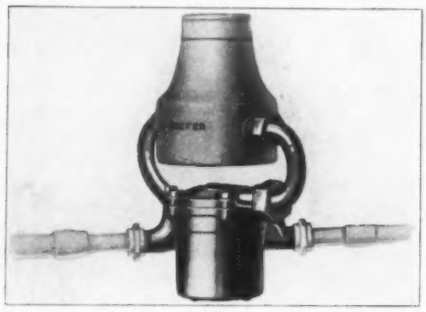
a new bulletin No. 128-D describing their "Primary Sludge Pump." Copy may be had by writing to the company's offices at 2336 Wolfram St., Chicago.

Ford Meter Box Company Announces the "Gulper"

What, with increased use of water-cooled gas operated refrigerators, air conditioning apparatus, minor fixture leaks and the Chinese custom of water stealing by running a thin stream continuously into storage vessels, water works men have come to consider more seriously the importance and magnitude of the volume of unaccounted-for water which passes unregistered

through meters. The introduction on the market of an instrument which will accurately measure *all* of the water passing a meter is therefore timely and of considerable interest. This instrument (measuring device) has been christened the "Gulper" by its manufacturers the Ford Meter Box Company, who developed it in collaboration with George G. Earl, Hydraulic Engineer, of New Orleans.

The natural limitation of, even the best, water meters to register minute flows can be overcome by use of a "Gulper" attached below any existing meter and set in the original position occupied by the meter



"Gulper" As Connected to Any Ordinary Meter.

proper, thus requiring no special piping or change in meter setting. Insertion of this "Gulper" merely raises the meter about 5 inches in its box.

The "Gulper"" renders a water meter as accurate, on flows of between one gallon per minute and no flow, as it is on rates above one gallon per minute. On flows above one gallon per minute the "Gulper" automatically stops functioning, the water flowing as usual through the meter. The basic principle of operation of the "Gulper" is that it changes continuous or intermittant low rates of flow, that do not register accurately if at all, to an intermittant and practically instantaneous rate of approximately 2 gallons per minute which is capable of rotating the meter disc to register accurately. The instrument literally lets the water through in measurable gulps instead of a trickle which explains the origin of the name "Gulper." The Standard Model A "Gulper" is made of the water works bronze and weighs 10 lbs. The bellows actuating it is made of high grade rubber. Its use can not make a meter over-register but prevents under-registration.

Aside from use as a "stop-loss" adjunct to meters in continuous use, the "Gulper" may be utilized as a test instrument for shop or field testing of meters; for determining flow characteristics of a service; to detect the existence of small leaks and their economic importance, or to arrive at water required by equipment such as gas refrigerators, humidifying apparatus, etc. A Meter-Gulper combination will prove very useful as laboratory or testing station equipment or for measuring precipitation caught in rain gauges which have been sufficiently elevated to supply head to operate the "Gulper" and meter.

For additional information concerning this interesting device the reader should request a copy of Gulper Catalog No. 1 from the Ford Meter Box Company, at Wabash, Ind.

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WITH THE MANUFACTURERS

W. McL. Bingley Appointed Chlorine Institute Engineer

W. McLean Bingley has recently been appointed assistant sanitary engineer of The Chlorine Institute, Inc., 50 E. 41st St., New York, N. Y. Mr. Bingley, a graduate of Johns Hopkins University, was formerly

W. McLean Bingley

in the employ of The Dorr Company. The Institute starts its eighth year of research in the chlorination of sewage, industrial wastes and related matters under the technical direction of L. H. Enslow, Sanitary Engineer of the Institute, and with Mr. Bingley as his assistant.

▲

F. J. King Elected President of Compressed Gas Manufacturers' Association

F. J. King, chief engineer of the Linde Air Products Company, was elected president of the Compressed Gas Manufacturers' Association at the annual meeting held at the Waldorf-Astoria in New York, Jan. 23 and 24, 1933.

F. J. King, Chief Engineer, Linde Air Products Co., President, Compressed Gas Manufacturers' Association, 1933

This election marks another recognition of Mr. King's outstanding contributions to technical progress in the compressed gas industry.

▼

Richard N. Statham Now at Chicago Office Industrial Chemical Sales Co.

Richard N. Statham has joined the staff at the Chicago office of the Industrial

Richard N. Statham

Chemical Sales Co., Inc. Mr. Statham is a graduate of Dartmouth College and was employed at the company's laboratory at the Covington, Va., plant before becoming affiliated with the Chicago office. Mr. Statham is the son of Noel Statham, president of the Industrial Chemical Sales Co., Inc., who has been known for many years as a pioneer in the field of electro chemistry. Noel Statham took out all of the patents covering the manufacture of the company's product, Nuchar, and also covering Snow Top precipitated chalk.

▼

Largest Sewage Screenings Incinerator in the World to Be Installed by Los Angeles

The Morse Boulger Destructor Company of New York City has just been awarded the contract for the erection of a sewage screenings incinerator plant by the city of Los Angeles, Calif. This plant will be located adjacent to the North Hyperion screening plant, which employs Dorrco fine screens and is the largest plant of its type in the world.

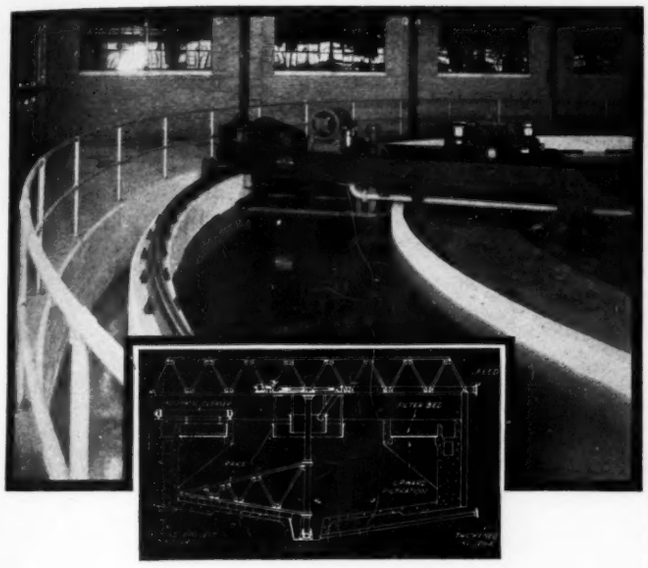
The specifications issued by the city of Los Angeles called for a plant to dispose of 50 tons of fine screenings per day, the screenings to contain from 85 to 90 per cent moisture content. The design was left entirely with the bidders, experience in this particular class of work being an important element considered in the bidding.

A bulletin describing destructors for the sewage field has recently been issued by the Morse Boulger Co. at 205 E. 42nd St., New York City.

FILTRATION EQUIPMENT CORPORATION

LAUGHLIN CLARIFYING TANK

For the Better Removal of Suspended Solids from Sewage and Industrial Wastes



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—Filter bed embraces entire circumference of tank, extending inwardly five feet or more.

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—Low power and low operating cost.

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Much stronger than the FERRIC CHLORIDE solutions heretofore known to the trade.

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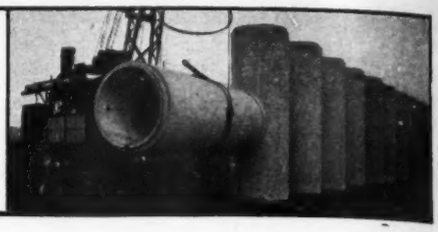

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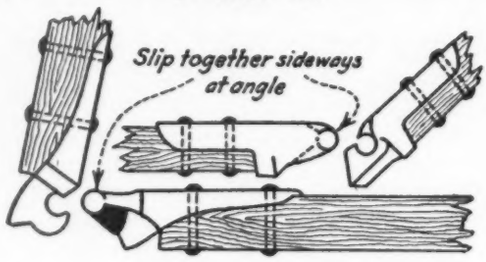

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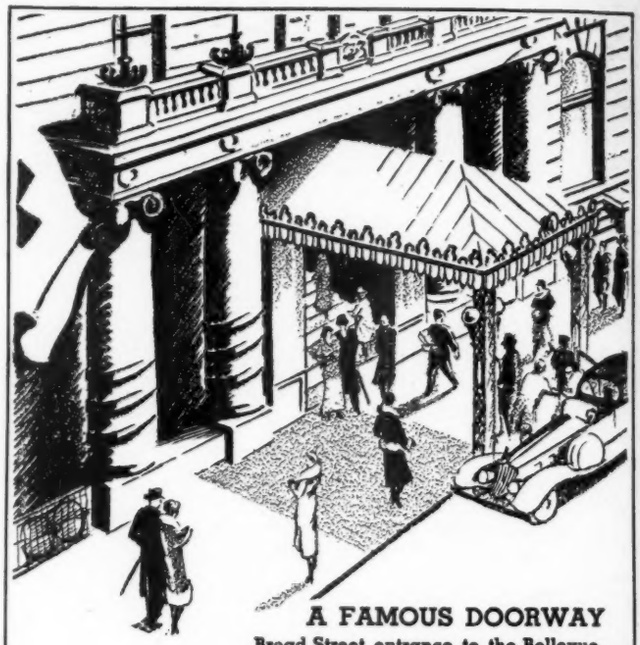

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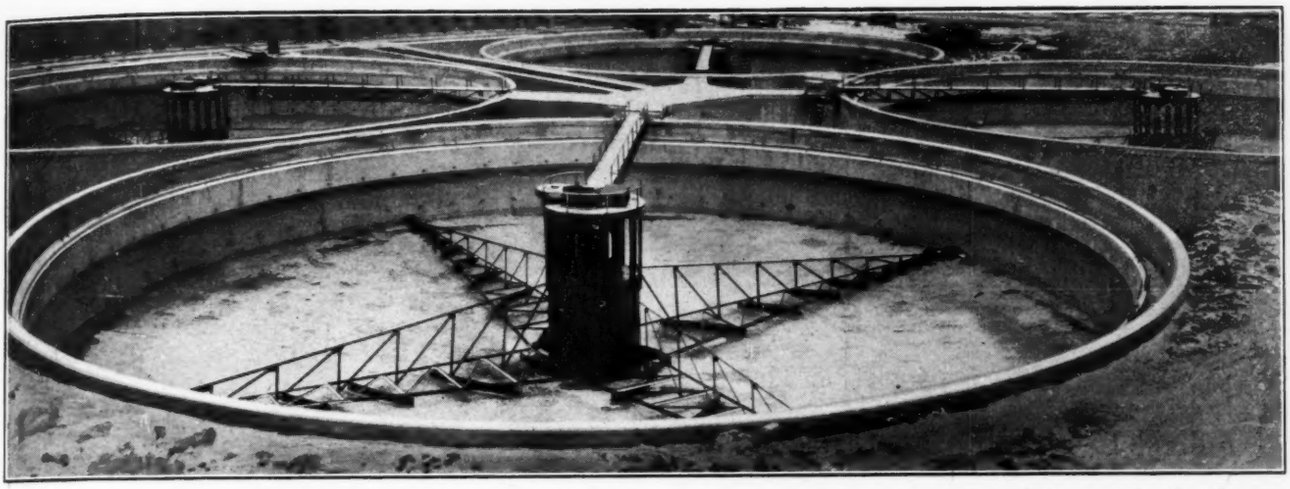
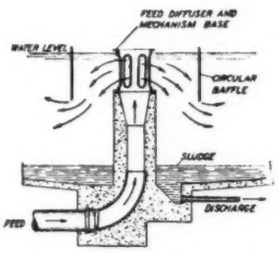


Four of the sixteen 112 ft. dia. Dorr Sifeed Clarifiers being installed at Cleveland's new Easterly Sewage Treatment Works. George B. Gascoigne, Consulting Engineer Note central feed diffuser, peripheral overflow weir and compact drive unit on center column



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Sedimentation *plus* is what you get from your new Dorr Sifeed Clarifier. You obtain either a greater capacity per unit of tank size or, conversely, a greater removal of suspended solids at former rates of flow.

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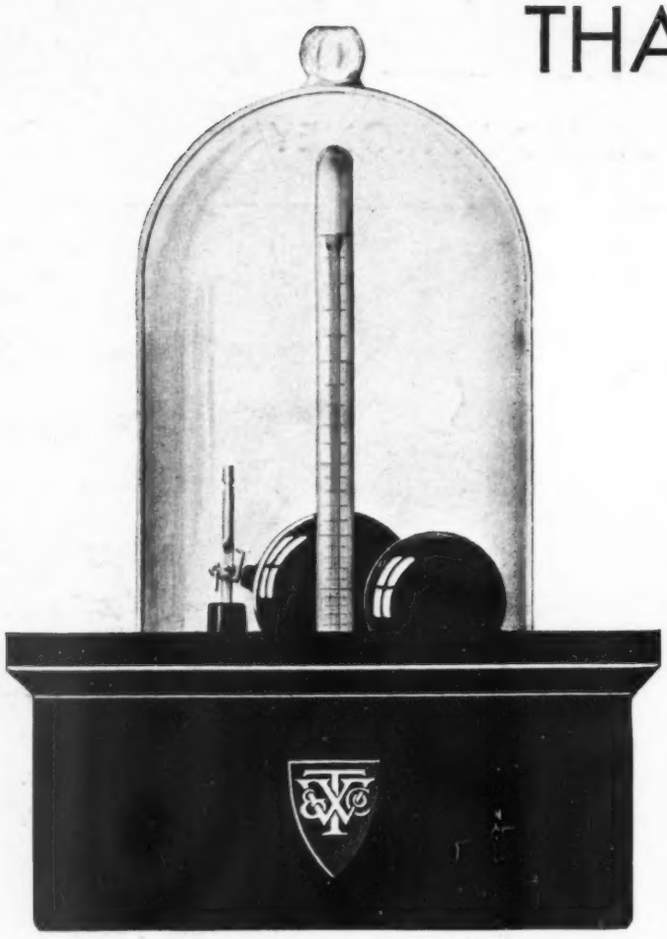

Irvin Cobb wasn't talking about Vacuum chlorinators when he made that remark — but he might well have had them in mind.

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